GEFORCE GTX 1060

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APC

Sept 2016
Issue 432

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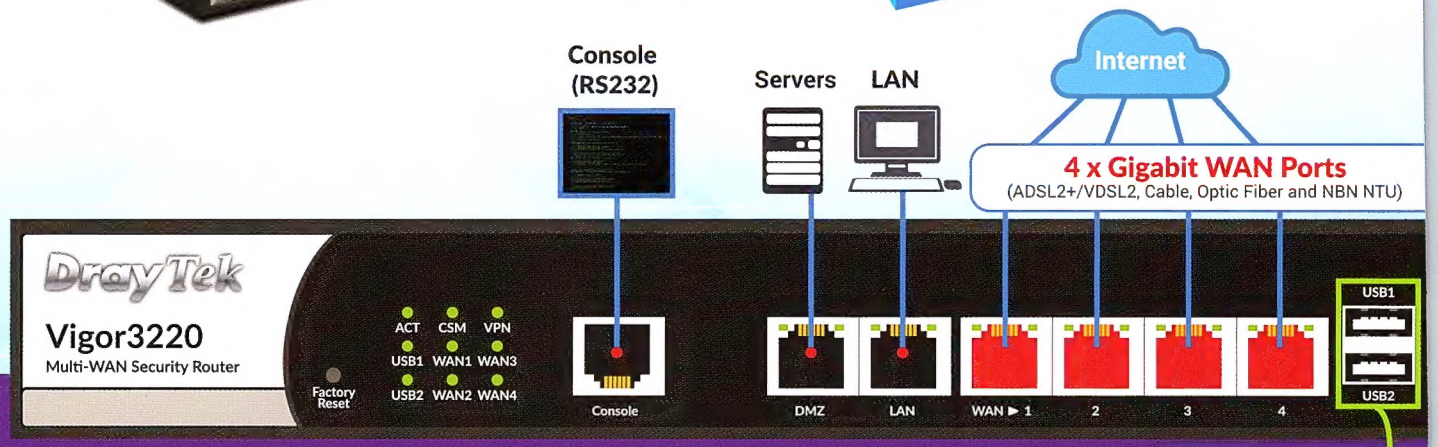

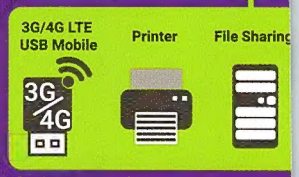

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Future Publishing Australia,
PO Box 1077, Mount Street, North Sydney, NSW 2059
Tel: 02 9955 2677 Fax: 02 9955 2688
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EDITORIAL
Editor-in-Chief **Dan Gardiner**
Sub-Editor / Journalist **Carmel Sealey**
Senior Journalist **Paul Taylor**
Senior Journalist **Shaun Prescott**
Journalist **Joel Burgess**
Journalist **Stephen Lambrechts**

ART/PRODUCTION
Creative Director **Troy Coleman**
Senior Designer **Nykke Coleman**
Designer **Sharnee Brisbourne**

CONTRIBUTORS
Jonni Bidwell, Helen Bradley, Alex Campbell, Matt Clapham, Ian Evenden, Craig Grannell, Lindsay Handmer, Gary Marshall, Matthew JC. Powell, Samuel Roberts, Phil Savage, Tom Senior, Zak Storey, Nathan Taylor, Alexander Tolstoy, Luis Villazon, Mark Wilson, Darren Yates

SENIOR MANAGEMENT
Managing Director APAC **Neville Daniels**

COMMERCIAL
Sales Director **Paul Marttila**
paul.marttila@futurenet.com

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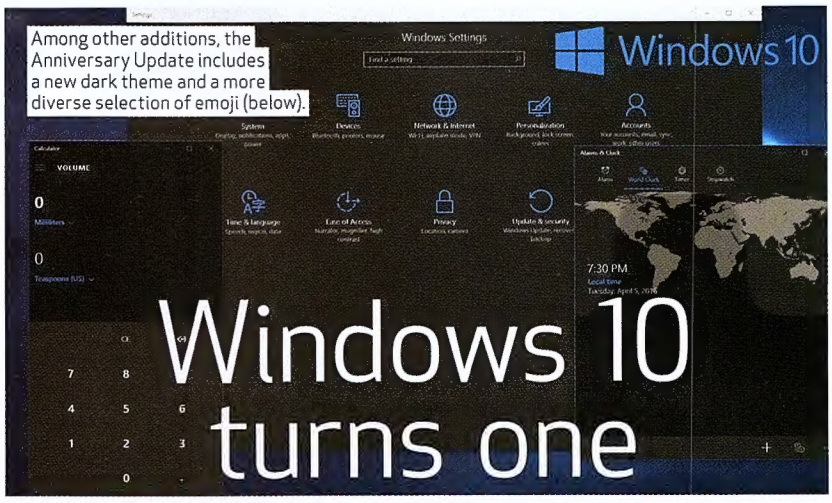

Among other additions, the Anniversary Update includes a new dark theme and a more diverse selection of emoji (below).

Microsoft's latest OS refresh has been out a full year but there are more changes incoming. *APC*'s editor ponders whether that'll be enough to keep it on top.

While Windows 10 hasn't quite rejuvenated the PC market like many analysts were hoping, it certainly seems to have lead to an increase in the sales of hybrid tablet/laptop 2-in-1 devices.

The free upgrade offer is over, so if you haven't yet pulled the trigger, you'll need to fork out $179 to be able to change up from Windows 7 or Windows 8.1. (Well, maybe. At the time we went to press, it was still possible to get the update for free via a loophole.) If you're just using it on your desktop, Windows 10 is admittedly a little hard to get excited about, as it largely just works the way you'd expect.

Microsoft's recent Anniversary Update isn't going to change that. While the update does include a host of new features, many will require specific hardware. If you've got a Surface Pro or a stylus-driven tablet, there's Windows Ink – an app for stylus users that includes smarter sticky notes (which can now do things like recognise and add calendar events), a quick way to share doodles and scribbles and a screenshot annotation element.

Also new is the fact that Windows Hello, Microsoft's biometric face-recognition/fingerprint system that's intended to replace your passwords, will get third-party app integration. Previously, you could only use it in limited spots, like logging into Windows, but post-Update, we should see a bunch of non-Microsoft apps using it.

More broadly useful features include an upgrade to Cortana – she's getting slightly better integration with Outlook and Office and will be a bit more sophisticated thanks to better context-sensitivity. She'll also be available to execute certain commands straight from the lockscreen.

Edge is (finally) getting extensions, so if you abandoned Microsoft's built-in browser because you couldn't block ads or your favourite password manager didn't work, you should soon be able to download relevant extensions from the Windows Store.

The Anniversary Update was set to roll out a day after this issue went to print, so if you've spent some time with it, flick us an email to **apcmag@futurenet.com** and let us know what you like and dislike about it. And from a broader perspective, what do you think of Windows 10, now that a full year has passed? Are you happy with Microsoft's latest or, like some readers who've recently written into us, are you considering making a switch to another OS or platform – like Linux or Mac? ■

DAN GARDINER
EDITOR-IN-CHIEF
dan.gardiner@futurenet.com

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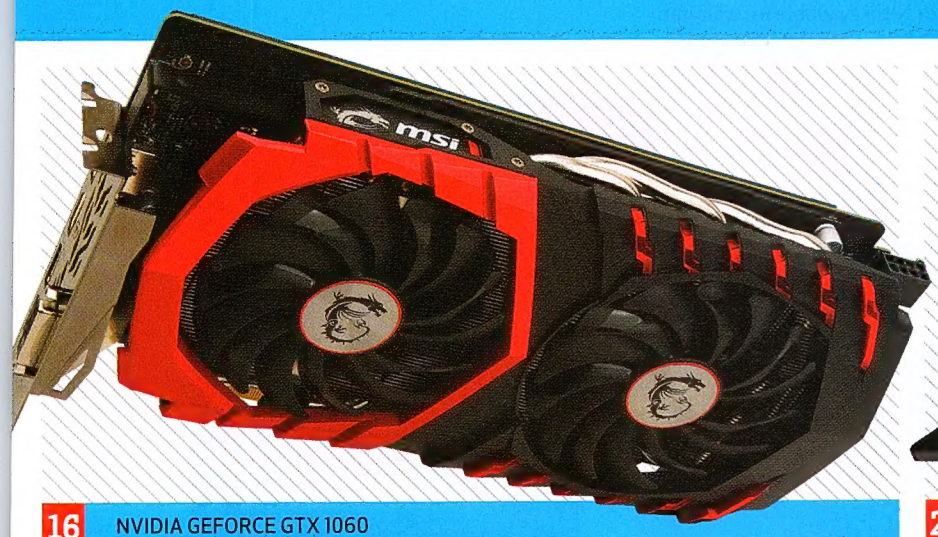
"Even in the hands of our specially trained mouse-testing sasquatch, moving from one button to the next requires a bit of stretching." ASUS RoG Spatha, page 22.



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ISSUE 432, SEPTEMBER 2016

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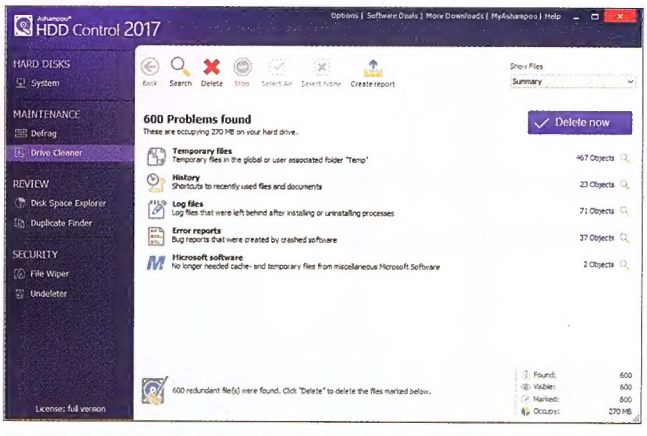

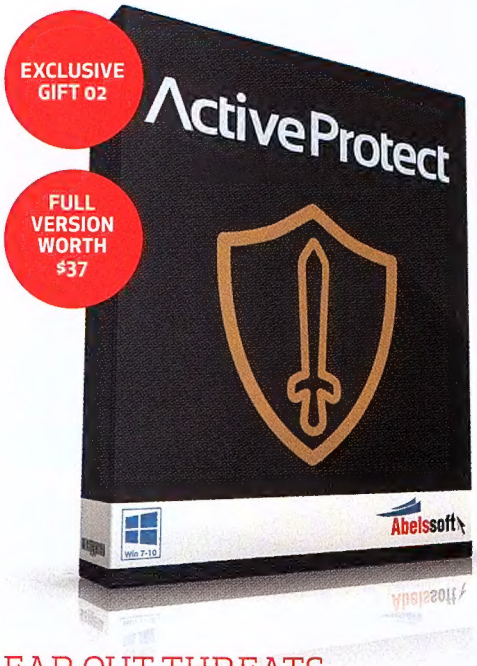

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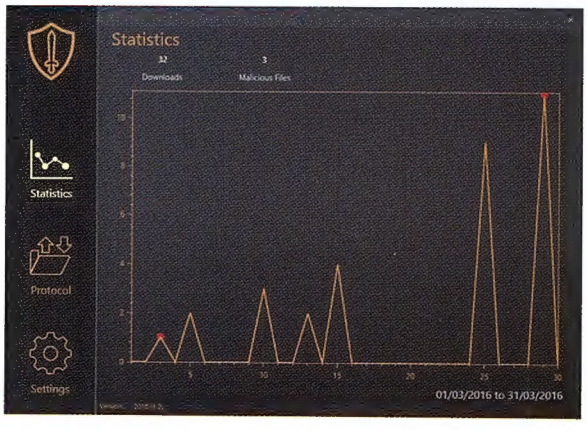

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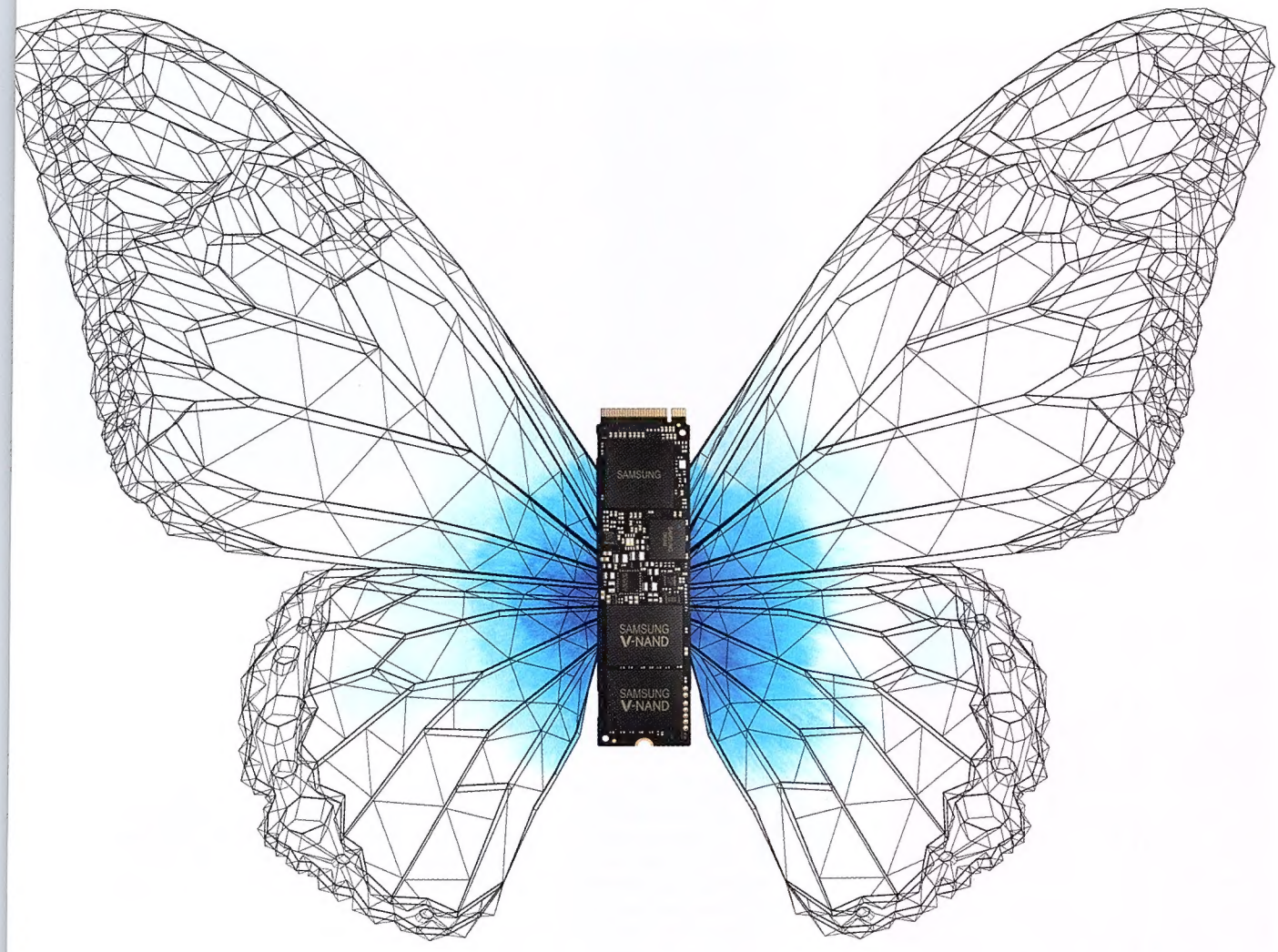
SAMSUNG



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*Performance benchmark product : 950 PRO(512GB)

technotes

» NEED TO KNOW

UN condemns governments that restrict its citizens' internet access

IT'S A "VIOLATION OF INTERNATIONAL HUMAN RIGHTS LAW".

The United Nations Human Rights Council has formally denounced countries that deny or limit their citizens' access to the internet, stating that "the same rights that people have offline must be protected online". The UN equated 'freedom of expression' to 'choice of media', saying each deserved the same level of protection. It also condemned "measures to intentionally prevent or disrupt access to or dissemination of information". SL

Smartphone ransomware on the rise

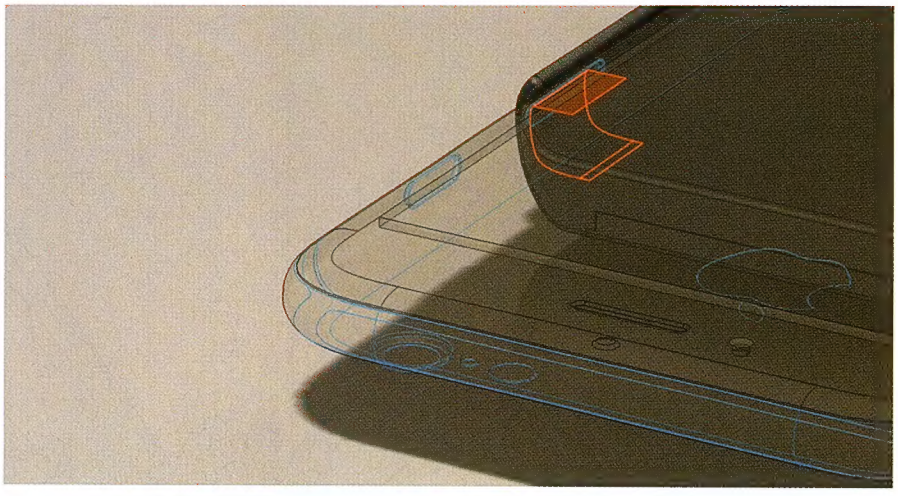
MOBILE DEVICES ARE MORE VULNERABLE THAN EVER.

According to a report by Kaspersky Lab, smartphone ransonware infections have escalated dramatically in the last few years, with attacks increasing almost four-fold in the last year alone. Kaspersky mobile security expert Roman Unuchek says "the extortion model is here to stay" and that it's "likely that it will be followed up with malware targeting devices that are very different to a PC or a smartphone". SL

Apple developing a reality TV show

PLANET OF THE APPS WILL CHALLENGE CONTESTANTS TO CREATE COMPELLING APPS.

The pun-tastically-titled *Planet of the Apps* has been announced as Apple's first original show for its Apple TV platform. The reality-based programme will follow a hundred of the world's most talented apps creators as they compete against each other. Sounds great for us geeks, but will it captivate the world in the way that Netflix's *Daredevil* or *House of Cards* has? SL



Edward Snowden's iPhone case will tell you if you've been hacked

And helps you stay off the grid.

When he isn't giving away government secrets, Edward Snowden also likes to design phone cases. Having not owned a smartphone since he began leaking classified NSA documents that exposed the United States Government's global surveillance program, Snowden has begun working on a smartphone case that will apparently detect and fight against government snooping.

According to Snowden, the case would use the phone's SIM slot to monitor and shut down a phone's radios if unauthorised access is detected, forbidding the handset from relaying any signals back to the uninvited intruder. This would also prevent governments or blackhat hackers from tracking you. The case will reportedly feature a simple monochromatic screen to alert users when their phone is broadcasting unusual signals. Helping Snowden with the project is American hacker Andrew "bunnie" Huang, a man who holds a PhD in Electrical Engineering at MIT and is best known for hacking the Xbox. Still in the design stages, Snowden and Huang expect to have a working prototype by the end of the year. **Stephen Lambrechts**

ACCC to investigate ISPs' broadband speed claims

THE CONSUMER WATCHDOG IS OFF ITS LEASH.

Fed up with internet companies falling short of their speed promises, the Australian Competition and Consumer Commission (ACCC) has launched a public inquiry into why they fail to deliver on their advertised speeds. According to the ACCC's consultation on broadband speeds discussion paper, "Consumers are entitled to expect clear and accurate information about the performance characteristics of a service they have purchased or are considering switching to," stating that advertised potential maximum speeds "misrepresent the speeds that the retail broadband service can consistently achieve, especially during peak periods when most consumers will want to use the service". The ACCC says, "A lack of accurate information increases the likelihood that consumers will misunderstand or be misled about the quality and capabilities of the broadband options available." The consumer watchdog says it's "also interested in views on whether similar issues are arising in the marketing of mobile broadband services". It also proposes the implementation of a national monitoring system, though it'd need $6 million from next year's budget to do so. **Stephen Lambrechts**

France orders Microsoft to stop collecting so much user data

SACRÉ BLEU!

Sick of Microsoft collecting excessive data on users of its Windows 10 operating system, the French data protection authority has ordered the tech giant to stop serving customers targeted ads without their consent. The Commission Nationale de l'Informatique has given Microsoft three months to cut its data collecting shenanigans, or else it could start a sanctions procedure. SL

IT industry body calls for e-voting in Australian elections

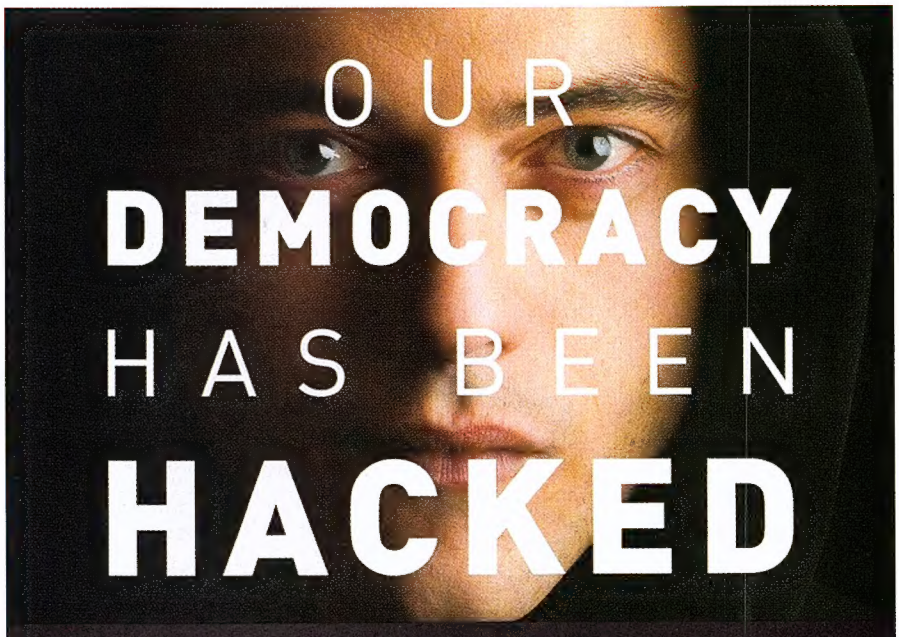
IMAGINE BEING ABLE TO VOTE FROM YOUR PHONE.

After the schmozzle that was Australia's 2016 Federal Election, the Australian Information Industry Association (AIIA) has called for an electronic voting system to be introduced. "With electronic voting in place, we would have known the results of our election minutes after the polls closed on Saturday, and everyone could get on with their jobs," said AIIA CEO Rob Fitzpatrick.

Intel looking to offload McAfee

AND ONLY FIVE YEARS AFTER ITS INITIAL PURCHASE.

Though it only purchased McAfee five years ago, Intel is already looking to offload its acquisition, now called Intel Security. BetaNews reports that Intel is not only looking for a way out of the security business, it also wants out of the PC chip-making scene, too. The company is reportedly turning its attention to making microchips for data centres and mobile devices. SL



US Democratic Party hack an act of 'internet terrorism'

Australian security experts tell all.

Recently, the Democratic National Committee (DNC) experienced an aggressive cyber attack which led to privileged (and rather damaging) emails being thrust into the public eye by WikiLeaks, seriously damaging Hillary Clinton's Presidential campaign in the process. According to the The Australian Centre for Cyber Security at the University of New South Wales, Canberra, the hack should be considered an act of 'internet terror' due to its ability to severely impact the political cycle, as it was directed at the liberal democracies by either non-state actors or by states themselves, as reported by Gizmodo. In response to the attack, the White House unveiled a new Presidential Policy Directive (PPD), which details how the United States should respond to cyber incidents which threaten national security. Professor Greg Austin says that "the new PPD, which calls for retaliatory action if appropriate, will be severely tested as the FBI conducts its investigation into the hack of the Democratic Party since Russia has been implicated by some in the attack." **Stephen Lambrechts**

Time's up for VCRs

LAST JAPANESE MANUFACTURER HITS 'STOP' ON PRODUCTION.

Unable to continue its status as the last-known company still manufacturing video cassette recorders, Japan's Funai Corporation has decided to hit 'Eject' on its production of VCRs. Funai cited "difficulty acquiring parts" as the main reason for throwing in the towel, though we have to imagine that catering to a niche market of VHS enthusiasts doesn't exactly rake in the cash. SL

technotes

» CARMEL SEALEY LOOKS AT THE NUMBERS DRIVING THE NEWS

6 terraflops

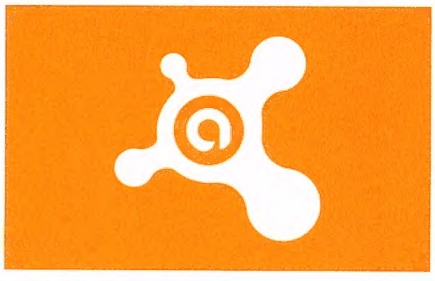
HOW POWERFUL THE GPU IN THE UPCOMING XBOX SCORPIO CONSOLE IS RUMOURED TO BE.

Project Scorpio (which sounds like something from the James Bond universe) is Microsoft's recently announced Xbox console, which is purportedly going to be available in stores before the end of 2017. According to Microsoft, this blinged-up Xbox One — one of two new Xbox consoles the company announced at E3 this year — will support 4K, be VR-ready and pack 6 terraflops of graphics processing power, making it the "most powerful console ever".

3

HOW MANY KNOWN FAKE *POKÉMON GO* APPS ON THE GOOGLE STORE THAT WILL LOCK YOUR SCREEN.

According to research from Eset, an antivirus provider, at least three fake *Pokémon Go* apps have made their way onto the official Google Play store. While two scare users with threats of malware (getting them to buy expensive software to remove it), 'Pokemon Go Ultimate' locks your phone screen. Even after the malicious app is 'removed', it continues to run in the background, clicking on ads.



US $1.3B

HOW MUCH SECURITY VENDOR AVAST IS PAYING TO ACQUIRE RIVAL AVG.

In early July, California-centred security software developer Avast announced that it was acquiring its Netherlands-based rival AVG for US$1.3 billion (approximately AU$1.74 billion). While both companies concentrate on developing security software for PCs and mobile devices, the acquisition would allow Avast "to gain scale, technological depth and geographical breadth". Avast hopes to complete the deal before mid-October.

49%

HOW MUCH OF THE WEB'S TRAFFIC COMES FROM BOTS.

It seems strange that only 51% of internet traffic is from actual real-life human beings, considering what the net is for. But that other 49% is from pieces of code pretending to be web users, and not all of these bots are simply fake YouTube views or Facebook likes. According to research from security company Imperva, the increase in bad bot activity directly relates to the rise in cyber attacks, specifically with bots being used to target credit card fraud.

$665

THE AMOUNT A NASCAR TEAM HAD TO PAY IN BITCOIN RANSOM.

CSLR's crew chief Dave Winston this year fell victim to malware that corrupted all the team's operational spreadsheets on his laptop, threatening to bring the team's NASCAR race to an end before it had even begun. They paid the modest US$500 (~AUD$665) Bitcoin ransom amount and, luckily, the criminals followed through with the deal and released his files. Needless to say, the team now backs up its files...

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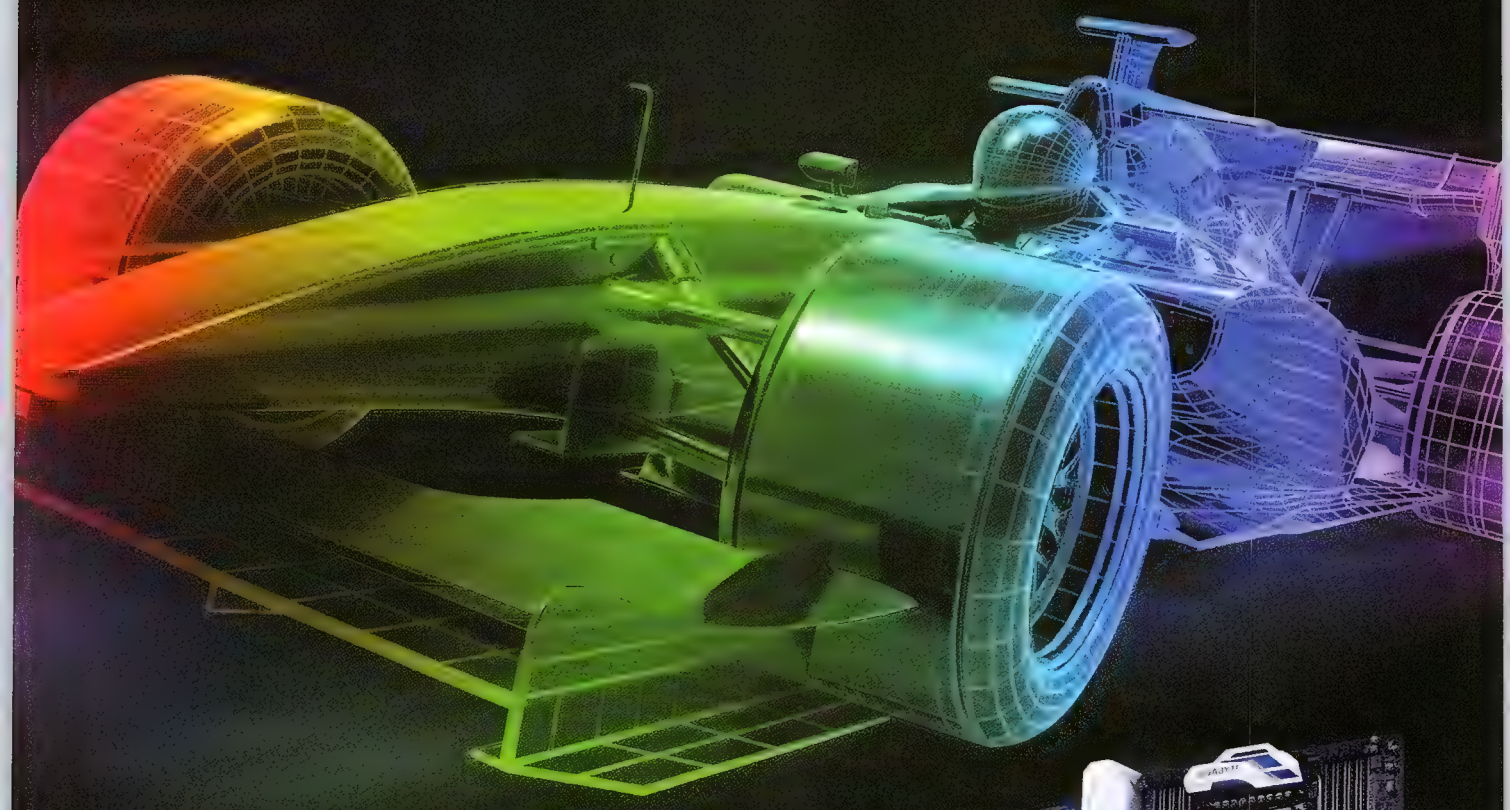

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www.gigabyte.com.au

*Features may vary by models. *The above photos are for reference only.

technotes

» GEAR WE WANT

RAZER MECHANICAL KEYBOARD CASE

A MECH SUIT FOR THE IPAD PRO.

WWW.RAZERZONE.COM | $260

You generally consider mechanical keyboards to be for the meticulous gamer or hardcore typist that likes just the right 'clicky key' feel, but Razer thinks iPad Pro users will like them too. Developing its own low-profile mechanical switch, Razer has tried to construct a portable keyboard case that closely reflects the experience of a full-sized mechanical 'board, with optimised actuation and reset points. The metal kickstand looks more sturdy than your what you get on your average iPad keyboard and you'll get between 10 and 600 hours use from a single recharge (depending on the backlight level) — although these enthusiast-level perks will also set you back a pretty penny. **JB**

LG ROBOKING TURBO + HOMEVIEW

LG'S LATEST VACUUM CLEANER DOUBLES AS A SECURITY GUARD.

WWW.LG.COM/AU | ~$1,799

The idea that your vacuum cleaner could be one of the most advanced pieces of technology in your home sounds like the butt of an old joke, but LG's Roboking Turbo may actually make the concept a reality. The Roboking Turbo will patrol the house for dust in much the same way as its predecessors, but with an added onboard security camera and the new HomeGuard security software, this autonomous vacuum cleaner will also keep an eye on your house for you while you're out. At $1,799, it's a bit more expensive that other robovacs, but a cleaner that'll also act as a security guard may just be the best combination for an autonomous droid yet. Now if they can just teach the next version kung fu... **JB**

NINTENDO CLASSIC MINI

ANOTHER BLAST FROM THE PAST FOR NINTENDO.

WWW.NINTENDO.COM/NES-CLASSIC | $99

The recent popularity of *Pokémon Go* has reminded many of Nintendo's successful heyday in the '80s and '90s, and the company is aiming to strike nostalgia gold again with a revamped NES machine that'll connect to your current TV via HDMI. For $99.95, Nintendo will bundle the upcoming unit with a controller and 30 pre-installed games, such as *Donkey Kong*, *Super Mario Bros.* and *The Legend of Zelda*. You'll be able to use the Wii's Classic Controller Pro with the device too, or alternatively buy additional NES controllers. The Nintendo Classic Mini also has no way of connecting to the internet or an external storage device, so if your favourite game isn't one of the bundled 30, you'll have to just leave it as a memory. [Or just fire it up in an emulator on your PC! — Ed] **JB**

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Kong Computer	1300 159 272	http://www.kongcomputers.com
JW Computers	(02) 9726 2818	http://jw.com.au
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Shopping express	(02) 8338 8899	http://www.shoppingexpress.com.au/

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Affordable laptops	(08) 9536 8500	http://www.affordablelaptops.com.au
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GAMING.MSI.COM

technotes

» EPINIONS

WINDOWS VS LINUX

In response to Walter's letter in last month's Epinions, I too am very interested to have a head-to-head comparison between Windows and Linux... and whatever else is out there.
J Rollinson

ANOTHER TENTATIVE LINUX SWITCHER

Count me in on a comprehensive article on Linux. I've already loaded a couple of versions on a laptop and desktop to learn its nuances. I'm over Windows 10, with Microsoft's attitude and the OS's niggling issues – particularly the constant reverting to its default apps despite my best attempts to stop it.
Ron Southgate

APC'S DEFINITELY THE MAG FOR ME! (ISN'T IT?)

I read with great interest Walter Jakubzik's letter in the Epinions section of *APC*'s August 2016 edition.

He raised a couple of good points. For example, the direction of *APC* and other tech magazines. I, also, am unhappy with this 'upgrading'. Maybe this is because I am what might be called a 'semi luddite'. Maybe it is because the target audience is more computer-literate than Walter and I. Maybe over time, we will become more 'edumicated'. Who knows? Miracles do happen.

APC has previously explained many technical terms, such as LTE & NAS etc. Unfortunately some of your older readers suffer from short-term memory loss. It would help us considerably if a glossary of relevant abbreviations was included in each and every issue.

Finally, please do not suggest, as you did with Walter, that *TechLife* magazine would better suit my needs. Money is short here, so 'she who must be obeyed' has decreed that only one computer magazine shall cross our threshhold and *APC* is the lucky winner.
Terence Jacobson

FAST FIXES FOLLOW UP

In the 'Fast fixes' cover story (see *APC* 426), it's suggested that to upgrade your Windows installation to an SSD requires the re-installation of Windows. This is not necessarily the case, as apps such as EaseUS Todo Backup (even the free version) can clone/migrate a hard drive to an SSD.

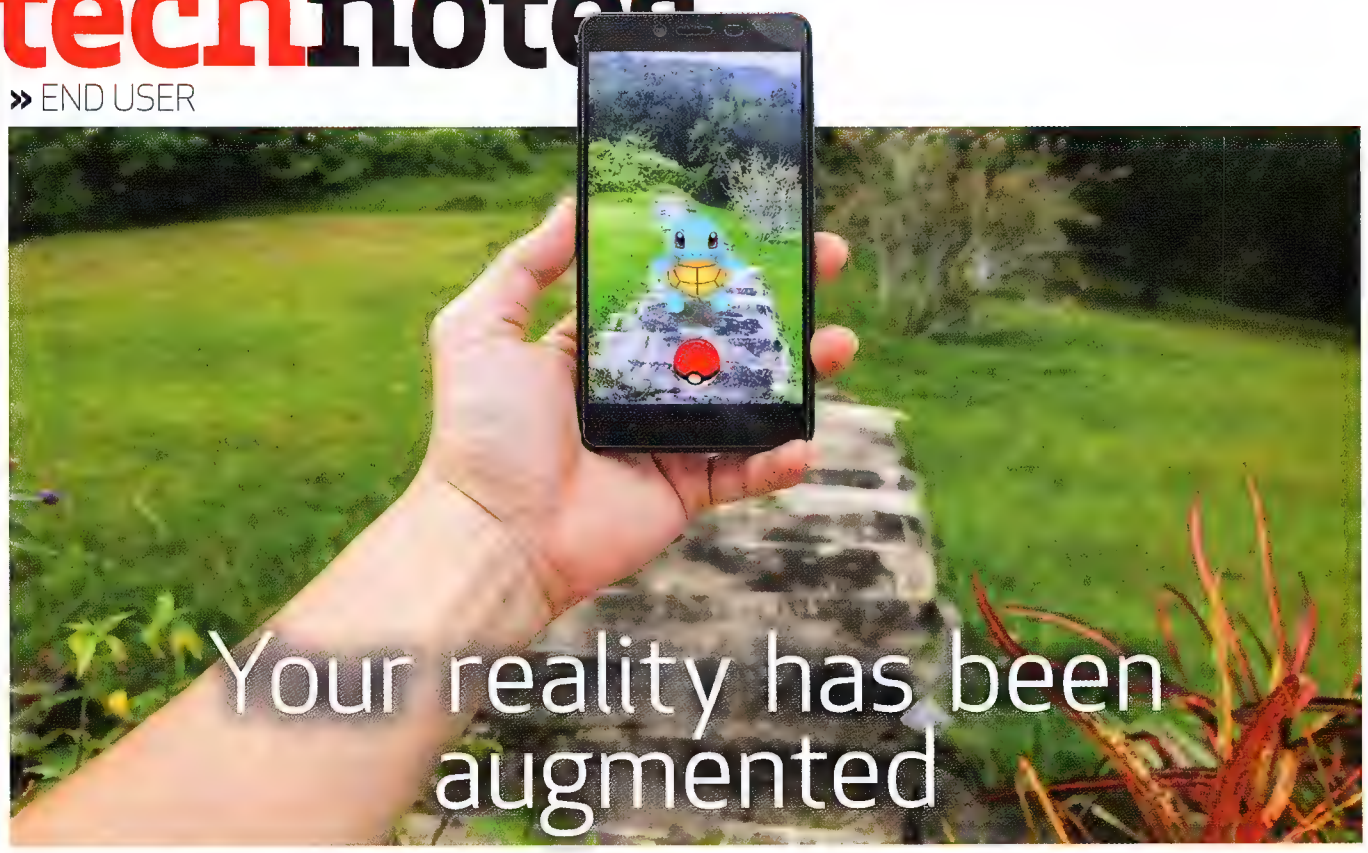
You simply clone/migrate the hard drive to the new SSD, shut down, turn off the power, remove the old hard drive, power up and reboot to the BIOS. Change the settings for first boot device/drive priority to the SSD, save changes and exit. The system should now boot from the new SSD containing the Windows OS. This process might vary slightly depending on the version of Windows.

Detailed steps can be found on the **todo-backup.com** website. This is a great app to keep on hand anyway! Once you've migrated, the old hard drive can be re-deployed for another purpose, such as a backup location.
Tony Davis ■

APCMAG@FUTURENET.COM

Come on, have your say!

We want to hear what you think. Add to these discussions or email your views (in fewer than 250 words) to **apcmag@futurenet.com**. All correspondence becomes the property of *APC* and is subject to editing. Letters must include full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.



Your reality has been augmented

Shaun Prescott weighs in on the *Pokémon GO* phenomenon.

While *Pokémon GO* didn't launch into a vacuum in July, it still had the impact of a tidal wave. Both specialist and mainstream media had reported on its impending launch, noting that it was likely to be a hit, given the strong demand for Nintendo-centric IP on smartphones. Few could have anticipated how much of a hit it would be, though, and not just in monetary and download terms: it's had a measurable impact on entire neighbourhoods.

The augmented reality title, which requires users to catch Pokémon in the real world, is based on the same technology US developer Niantic debuted with *Ingress*. It even uses the same data, meaning many of the hotspots and 'gyms' (ad-hoc Pokémon battle areas) are sourced from information uploaded to *Ingress*. But where Ingress was a niche concern that never threatened to spill out into public consciousness, *Pokémon* is, well... it's *Pokémon*. As of late July, it was raking in $1.6 million in the US alone, and the phenomenon served to boost Nintendo's shares by around $7 billion, which was interesting because it won't actually directly profit from the new mobile game. That kind of investor behaviour is proof enough that *Pokémon* is a fever, a kind of sickness, and like the deadly viruses at the heart of every B-grade zombie flick, its results are literally spilling out onto the street.

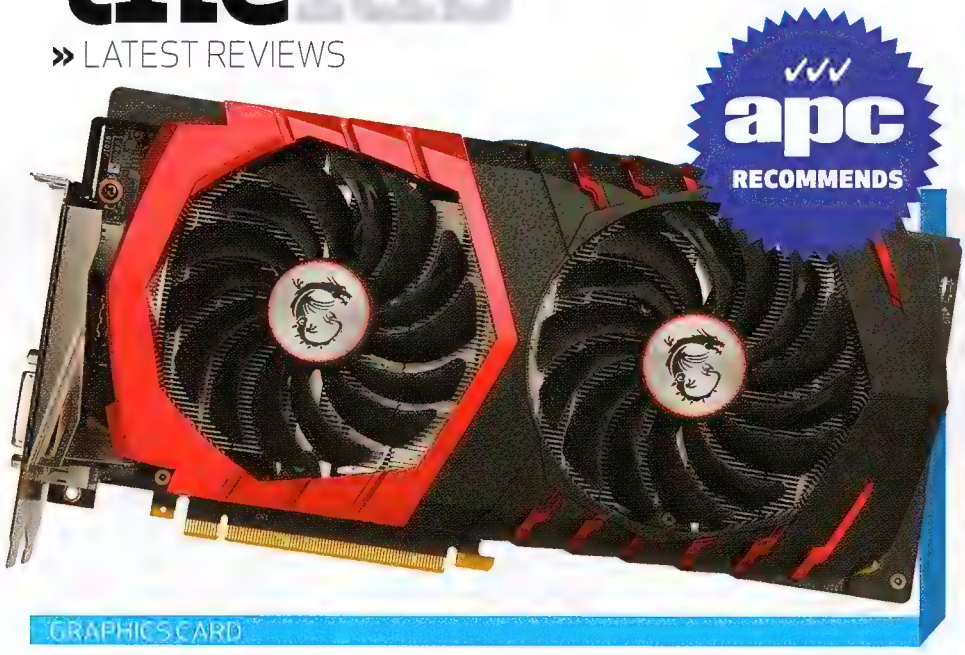
Take Rhodes, for example: the relatively quiet Sydney suburb, normally a home to city office workers and middle class apartment buildings, has been swamped nightly by *Pokémon* players. "There have been a number of concerning instances already, including an emergency services vehicle having difficulty reaching an apartment fire due to traffic congestion, traffic accidents and reports of motorcycles using cycle and footpaths to get around traffic congestion," general manager of Canada Bay city council Gary Sawyer told Domain. Meanwhile, not a day goes by without the media reporting on hapless *GO* players inadvertently trespassing, being hit by cars or being shot. Retail outlets are even using the game to attract audiences, while some are warning their customers to stay away if their only motive is to catch Pokémon. If you're living in an urban area, there is no escaping the app's influence now, whether you notice it or not.

Is it likely to endure, though? The short and rather unsatisfying answer is 'maybe'. If Niantic adds new functionality to the currently barebones app, it probably will. But like other forgotten phenomenons (remember *Draw Something* and *Words with Friends*?), it will likely die a rapid death if the Pokémon Company and Niantic can't keep it in the public spotlight. With forthcoming functionality that promises to make the game even more social, we suspect it will probably stick around for a long time to come. ■

ENDUSER

Share your stories!

If you have an iteresting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at **apcmag@futurenet.com**. All correspondence becomes the property of *APC* and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.



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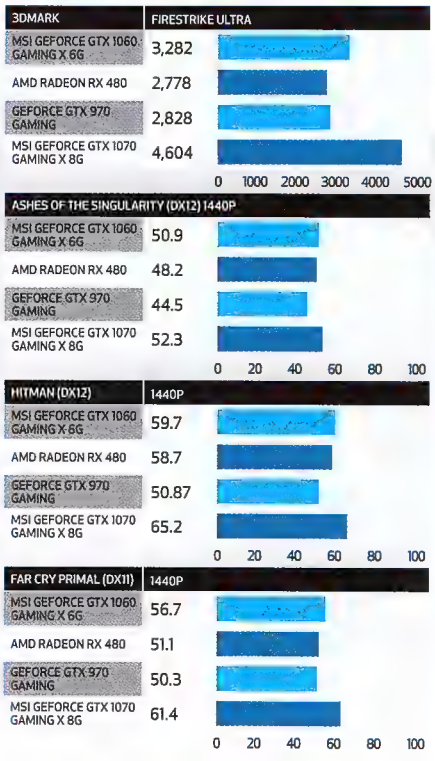
LABS BENCHMARK RESULTS

Gaming performance



MSI GeForce GTX 1060 Gaming X 6G

Hands-on with the latest GPU from team green.

The Nvidia GTX 1080 and 1070 introduced us to the new Pascal GPU architecture, but while very powerful, the cards are beyond the budget of many gamers. Enter the GTX 1060 – a more affordable option aimed at 1080p resolutions and entry-level VR.

The GTX 1060 uses the same 16nm process, but has a reduced number of shader and render output units. The 1060's GP106 core features 1280 shader units and 48 ROPs. By default, the core clock buzzes along at a base of 1,506MHz, boosts to 1,708MHz and the memory runs at 8,000MHz. The cards feature 6GB of GDDR5, and a 192-bit memory bus. In comparison, the GTX 1070 and 1080 have (respectively) 1,920 and 2,560 shader units and 8GB of RAM with a 256-bit memory bus.

The GTX 1060 ends up with about four terraflops performance, vs six and nine for the 1070 and 1080.

The MSI engineers have worked their magic and extracted extra overclocked performance from the 1060 core. In OC mode, the Gaming X card can boost to 1,809MHz from a base of 1,594MHz, and squeezes an extra 100MHz from the RAM. Gaming Mode is a step down, at 1,784/1,569MHz, boost/base clock, and Silent Mode runs at the default settings. Part of what makes this possible is the custom cooling solution, with Twin Forz VI heat pipes and Torx 2.0 fans. While chunky, the system runs very cool and quiet, and can stop the fans completely during low load.

What about performance? We ran the GeForce GTX 1060 through our favourite synthetic and gaming benchmarks, at 1080p, 1440p and 4K resolutions. While particularly tough titles such as *Ashes of the Singularity* can benefit from slightly reduced quality settings, the card has no problems maintaining excellent frame rates. It can also venture into 1440p and 4K gaming territories rather well, but it's still best for 1080p gaming.

In terms of price, the GTX 1060 competes with AMD's RX 480, and to a lesser extent, the GTX 970 – though the latter is solidly outclassed in performance. The 1060 more closely competes with the GTX 980, but the older card is significantly more expensive. The GTX 1060 tends to outperform the RX 480 in DX11, but isn't as far ahead in DX12 games. Depending on the model, the 1060 costs a little more and has less RAM.

The MSI GTX 1060 uses a single eight-pin power connector, and is rated at 120W, so for a normal PC, a 400W PSU can get the job done fine. On the back, it has three DisplayPort connections, as well as HDMI and DVI. The card also has funky built-in RGB LED lighting, to add a little bling to your build.

The other important aspect of the card is the bundle of software from MSI. The included Gaming App makes it easy to adjust everything from performance and sound level, to lighting, and can overlay important details when gaming. It even has an Android app, for separate management without needing to stop gaming.

Lindsay Handmer

Verdict

Features	★★★★
Performance	★★★★
Value	★★★½

Excellent mid-range performance for an affordable price, but still faces strong competition from the AMD RX 480.

★★★★

ULTRABOOK

$1,699 | WWW.ACER.COM.AU

Acer Aspire S 13 (S5-371)

A thin and light laptop that's just right (once you remove the bloatware).

Acer's new Aspire laptop primarily stands out for one reason: it's one of the best-value ultrabooks that's come through our labs. Acer has packed some surprisingly high-end hardware into this reasonably-compact 13-inch package; it's driven by a speedy 6th-gen Core i7 processor combined with 8GB of RAM and a spacious 512GB SSD. For that kind of kit in this kind of machine, you'd normally be looking at a pricetag above $2,000 (possibly even $3,000, depending on the brand), yet somehow, the S5-371 is selling for just $1,699.

What has Acer sacrificed to get that price so low? Not a lot that matters, it turns out. While this the chassis is mostly polycarbonate (AKA plastic), the keyboard deck is still made of a single rigid piece of aluminium, which helps to keep it nice and stiff and feeling relatively durable. It's quite slim when closed, 14.6mm, and the weight is only 1.3kg.

The 13.3-inch display is an IPS model at 1080p, meaning it's comfortable and offers good viewing angles. It didn't have the best contrast – blacks look a little grey – but colours in general were fairly neutral. Around the edges of the base, you get a reasonable sprinkling of connectivity options, too: three USB 3.0 ports (one of which is Type-C), a full-size HDMI video output, SD card reader and a headset jack.

The S5-371's performance is spot on with what you'd expect from the parts under the hood – while we've seen faster SSDs (this one tops out at around 500MB/s transfer speeds, while best-in-class are 2,000MB/s), the slim chassis doesn't seem to cause any heat-related throttling, as seen on some other ultrabooks. The three-cell lithium-ion battery even lasted longer than we expected – at 50% screen brightness, it'll give you around four hours of intensive use (which we tested with the PCMark 8 Home benchmark) or up to six hours for lighter tasks, like watching a 1080p video in VLC Media Player.

But there are some caveats worth noting. Acer has loaded this machine up with a fair amount of what we'd classify as bloatware – desktop shortcuts to services like Booking.com, eBay and dubiously-useful apps like the Dashlane password manager (which is technically free, but you'll need to buy a subscription in order to sync passwords to difference devices), although there are some vaguely pracitcal apps like a McAfee Antivirus trial.

Thankfully, bloatware isn't as difficult to get rid of as it used to be (try **pcdecrapifier.com** and **www.shouldiremoveit.com**).

As with so many other super-thin ultrabooks, this one has little space for chunky copper heatsinks, so it has to compensate for this with powerful fans. And in the heat game, 'small + fast' almost always equals 'high pitched'. Thankfully, those fans don't spin up often – you really have to be thrashing the hell out of the system (like running benchmarks) to hear them, although when you do, the whine they produce is certainly piercing.

Luckily, that happens so rarely that you'll likely never hear it – and they don't prevent this one from being a fantastic-value ultrabook. **Dan Gardiner**

LABS | BENCHMARK RESULTS

General and media-encoding performance

PCMARK 8	HOME (SCORE)
ACER ASPIRE S 13 (S5-371)	3,128
HP SPECTRE 13-V001TU	3,207

0 1000 2000 3000 4000 5000

1080P MEDIA ENCODING	HWBOT X265 (AVG FPS)
ACER ASPIRE S 13 (S5-371)	7.85
HP SPECTRE 13-V001TU	6.72

0 2 4 6 8 10

Disk speed

CRYSTAL DISKMARK 3	SEQUENTIAL READ (AVG MB/S)
ACER ASPIRE S 13 (S5-371)	558.1
HP SPECTRE 13-V001TU	1,242

0 500 1000 1500 2000 2500

CRYSTAL DISKMARK 3	SEQUENTIAL WRITE (AVG MB/S)
ACER ASPIRE S 13 (S5-371)	458.5
HP SPECTRE 13-V001TU	302.6

0 100 200 300 400 500

Gaming performance

3DMARK	3DMARK SKY DIVER (SCORE)
ACER ASPIRE S 13 (S5-371)	3,850
HP SPECTRE 13-V001TU	3,297

0 1000 2000 3000 4000 5000

Battery Life

PCMARK 8	HOME (HRS:MINS)
ACER ASPIRE S 13 (S5-371)	4:08hr
HP SPECTRE 13-V001TU	3:54hr

0 2 4 6 8 10

1080P VIDEO PLAYBACK	HRS:MINS
ACER ASPIRE S 13 (S5-371)	5:57hr
HP SPECTRE 13-V001TU	5:53hr

0 2 4 6 8 10

Verdict

Features	★★★★½
Performance	★★★★
Value	★★★★★

Ditches some of the premium extras, but still gives you a compelling mix of specs at a great price point.

★★★★½

apc RECOMMENDS

GAMING PC

ALPHA, $1,499; GRAPHICS AMPLIFIER, $199 | WWW.ALIENWARE.COM.AU

Alienware Alpha (2016) and Graphics Amplifier

Alienware's slim gaming PC for your TV is back for a second round, and it's brought a powerful friend along to help with the heavy lifting.

When the first Alienware Alpha launched in 2014, it did so amid growing enthusiasm for Steam Machines – living room PCs with small form factors and plenty of gaming power.

In fact, Alienware got a head start, launching before Steam had even rolled out its purpose-built Steam OS, and before many of its competitors brought their own interpretation of the form to the market. Since then, Steam Machines appear to have gone out of vogue, or at least, in-home streaming has emerged as the better option.

That's why the Alienware Alpha's second generation is so interesting. It retains the small form factor but this one's really intended to operate as a desktop PC rather than as something for the lounge room.

Three models are available in Australia, priced at $999, $1,299 and $1,499. The latter model is what we tested, and it boasts the best specs in addition to a 256GB solid state drive – the only Alpha of this generation to house an SSD.

The Alpha includes a wired mouse and keyboard in the box, rather than an Xbox or Steam gamepad controller. Unlike a gaming laptop (compared to which, the Alpha is tiny), the box is powered by true desktop components – in this top-end model, that means you get a Core i7-6700T processor and a GeForce GTX 960 graphics chip, although the unit we tested had a slightly lower-end processor than what's on the final retail model – an i7-6600T, which runs 100MHz slower than the retail version. Like earlier models, everything in the box can be upgraded except the GPU – at the cost of voiding your warranty, of course.

FROM THE COUCH

Running the Alpha as a Steam- and Windows-powered living room games console is smooth enough – you can boot straight into Steam Big Picture, and with the specs listed above, your experience is going to be better than a PS4 or Xbox One can offer. Most games are playable on high detail settings at 1080p, *Batman: Arkham Knight* hit 59fps for example, although ultra settings are a bit of a stretch – *The Division* only netted 32fps on ultra. The biggest benefit is access to Steam's massive games library, which towers above the marketplaces on any other platform. Still, RTS games and even FPSs aren't ideal on the rudimentary mouse and keyboard that comes with the package – if you're serious about PC gaming, you'll want to find more upmarket alternatives. Or else, you'll want to plug an Xbox 360 or One controller in. The Steam Controller has yet to pass certification in Australia, so Alienware cannot bundle it with the Alpha here, like they do in other regions.

The Alpha boots straight into the Windows 10 desktop, though this can be changed to either Steam Big Picture or Alienware's Hivemind, which must be downloaded separately and offers a TV-friendly user interface for accessing multimedia playback, as well as access to Big Picture or the desktop. The Alpha is mercifully lacking in bloatware: apart from Windows 10, there's only the Alienware Command Center (which allows certain settings such as the colouring of the LED lights on the unit to be changed) and McAfee's security suite.

In general, the Alpha emits about the same level of fan noise as the PS4: if you place it in your TV cabinet, you won't notice it, though as a desktop box that you'll be sitting close

apc HOT PRODUCT

"The Alpha includes a wired mouse and keyboard in the box, rather than an Xbox or Steam controller."

LABS BENCHMARK RESULTS

General performance

PCMARK 8	(SCORE)
ALIENWARE ALPHA (2016)	4,393
ALPHA + GRAPHICS AMPLIFIER (980 TI)	4,326

0 1000 2000 3000 4000 5000

Media-encoding performance

HWBOT X265	AVG FPS
ALIENWARE ALPHA (2016)	14.25
ALPHA + GRAPHICS AMPLIFIER (980 TI)	16.6

0 5 10 15 20 25

Disk performance

CRYSTAL DISKMARK 3	SEQUENTIAL READ (AVG MB/S)
ALIENWARE ALPHA (2016)	1,543

0 500 1000 1500 2000 2500

CRYSTAL DISKMARK 3	SEQUENTIAL WRITE (AVG MB/S)
ALIENWARE ALPHA (2016)	311

0 100 200 300 400 500

Gaming performance

3DMARK	FIRE STRIKE (SCORE)
ALIENWARE ALPHA (2016)	6,283
ALPHA + GRAPHICS AMPLIFIER (980 TI)	13,789

0 3000 6000 9000 12,000 15,000

THE DIVISION	1080P ULTRA (AVG FPS)
ALIENWARE ALPHA (2016)	32.4
ALPHA + GRAPHICS AMPLIFIER (980 TI)	72.2

0 20 40 60 80 100

FAR CRY PRIMAL	1080P ULTRA (AVG FPS)
ALIENWARE ALPHA (2016)	34
ALPHA + GRAPHICS AMPLIFIER (980 TI)	52

0 20 40 60 80 100

to, it will make itself known. During our games testing, its internal fans did ramp up to a very audible level.

Overall, paying $1,499 for a unit with these specs isn't as attractive as they might be in other territories where pricing might be more ideal. If you must game on a hassle-free small form factor box, it's a fairly compelling option – but it's worth reiterating that the GPU cannot be upgraded, and on its own, the Alpha isn't exactly VR-ready.

A NEW FRIEND

However, if that's what you're aiming for, Alienware does have an add-on that can help out. The $199 Graphics Amplifier is a rectangular enclosure with its own 460W power supply and it's designed to let you install your own PCI-Express desktop graphics card. The Amp (as it's known) will plug straight into the two higher-end Alphas (those with a GeForce GTX 960 GPU) or any 2016 Alienware laptop, via a proprietary Alienware connector. We plugged in a GTX 980 Ti and found the process straightforward.

With the GTX 980 Ti in place, we fired up the benchmarks again and managed to get 82fps in *Batman: Arkham Knight* on high and 72fps in *The Division* on ultra. We were also able to play most available titles on our Oculus Rift with no problem, including *House of the Rising Sun* and *The Vanishing of Ethan Carter*. Obviously, buying a $1,499 Alpha, a $199 Amplifier and then a new GPU isn't the most cost-effective way to start using VR (especially if you don't already own a headset), but it does demonstrate that the Alpha is more flexible than its console brethren, and upgrading the GPU in an Amp is less intimidating than it is with a regular desktop PC.

Like Razer's similar upcoming Core attachment, the Graphics Amplifier also has four USB 3.0 expansion ports; useful for adding extra storage or plugging in peripherals. Alienware's devs have focused on simplifying the overall user-experience, too: it's easy to use, it warns you if it's disconnected, and it can actually help to reduce overall system noise because the Alpha's internal GPU isn't used when you've got the Amp connected – although that said, CPU-intensive titles will still result in the Alpha's fans cranking up.

So should you buy an Alienware Alpha? It's an undeniably charming device, and considering the power of its innards, it's almost impossibly small at 200mm x 200mm x 55mm. The higher-end model – and even the lower-end model – are far more expensive than a console, but it's important to note that this is a fully-functioning PC: you could feasibly use it as your main work desktop, and then carry it into the lounge room for gaming.

It's looking unlikely that Steam Machines will revolutionalise the console market – at least for the next couple of years, especially with Sony and Microsoft moving to more iterative cycles – but this is a fairly flexible and powerful little unit. So if the convenience is what you want, maybe the price is right. ■ **Shaun Prescott & Dan Gardiner**

Alienware Alpha (2016)

Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★½

A respectable upgrade makes the Alpha a slightly better all-rounder. You're still paying for the form-factor, though.

★★★★½

Alienware Graphics Amplifier

Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★★★

This surprisingly-affordable add-on can seriously rev up a compatible Alienware laptop or Alpha. Highly recommended.

★★★★½

apc HOT PRODUCT

GAMING LAPTOP

FROM $2,999 | WWW.RAZERZONE.COM

Razer Blade (2016)

Sleek gaming on the go.

The Razer Blade takes some of the gaming chops of a full-featured notebook or gaming laptop, and stuffs them into a form closer to that of a MacBook Pro. The 14-inch Blade has a smooth, black, powder-coated aluminium finish. It comes with Intel's Skylake Core i7-6700HQ, like many gaming notebooks. The 6700HQ's base clock comes in at a respectable 2.6GHz, with a turbo clock of 3.5GHz. In contrast, the current-generation 15-inch MacBook Pro, at the same price as the Blade, sports a previous-generation i7-4770HQ Haswell CPU, with a base clock of 2.2GHz and turbo of 3.4GHz.

The Blade also comes with a hefty 16GB of RAM, and either a 256GB (reviewed) or 512GB Samsung PM951 SSD. The pixel-pushing power comes from a GeForce GTX 970M with 6GB of VRAM. That's an improvement over the previous Blade, which only had 3GB, like most gaming laptops with the 970M. In our benchmarks, the 6GB served the Blade well, giving us solidly playable frame rates in *Far Cry Primal*, *Rise of the Tomb Raider* and *The Division* at 1080p at Ultra settings (*Rise of the Tomb Raider* is run with SMAA and Very High settings). You won't hit 60fps at Ultra, but by tuning some effects back to High or Medium, it's within reach. It's worth noting that the Blade got pretty damn hot. But what impressed us was where it got hot. Heat is concentrated near the hinge – the rest of the laptop stayed impressively cool, even under high loads.

The keyboard offers Razer's Chroma RGB LED illumination, which can be controlled from Razer's Synapse software. If you've ever used a Razer Chroma keyboard, all of the same options are there in Synapse. The keys are scissor membrane switches, but felt responsive, as did the trackpad.

We left the Chroma illumination on for our battery test, and still managed 6 hours and 38 minutes while playing a 1080p movie on loop with Windows' Power Saver mode enabled. We kept the screen at 50% brightness, which equaled about 150 nits, instead of the 200 we usually test at.

In terms of connectivity, it offers a respectable array of options, including three USB 3.0 ports – two flanking the left side and one on the right. The right side also features a Thunderbolt 3 connector, as well as an HDMI connector and Kensington lock. The left side has an audio jack, too. For networking, the Blade comes with Killer's Wireless-AC 1535 802.11 a/g/b/n/ac, which offers Bluetooth 4.1 for wireless pairing. Bonus points here, because Killer offers support for Debian and Ubuntu Linux via the ath10k kernel driver.

There's no RJ45 connector, but that's because it's so thin. An RJ45 jack can range from 11.5mm to 13.5mm in height. At 17.8mm (including the lid), the Blade is just a hair thinner than the MacBook Pro. There is a trade-off, though, as the thicker laptops have enjoyed better benchmark scores, likely due to the extra room for heat dissipation.

If you're a gamer on the go who doesn't want to carry around an eight-pound laptop requiring a backpack, we recommend you look at the Blade. Also, if you're a creative who likes the MacBook Pro's build quality, but prefers Windows or Linux, this laptop offers the same premium feel and more power for the same price. ■ **Alex Campbell**

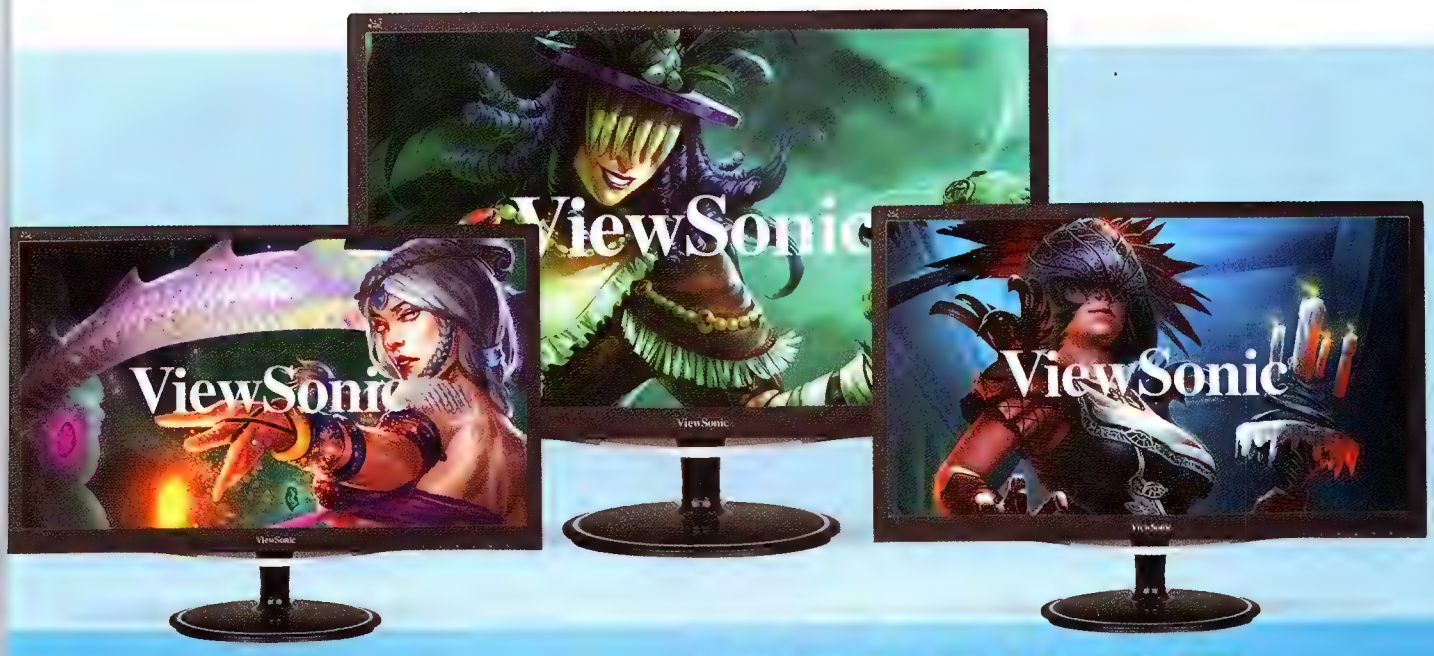
Verdict

Features ★★★★½
Performance ★★★★½
Value ★★★½

MacBook Pro-like smooth aluminium build; 6GB VRAM; most of the body stays cool under load; long battery life.

★★★★½

ViewSonic
See the difference™



GET THE SCREEN OF YOUR DREAMS

VIEWSONIC'S VX57 SERIES MONITORS ARE BUILT TO PROVIDE THE ULTIMATE IN GAMING AND ENTERTAINMENT EXPERIENCES — AND THEY WON'T BREAK THE BANK.

Getting the best gaming experience on a budget can be a tricky balancing act, but ViewSonic has just made it a whole lot easier with the VX57 Series. Available in 22", 24" and 27", these monitors combine higher-end features such as AMD FreeSync with a very affordable price tag. All three models use 1080p panels, with excellent response times and gamer-focused functionality. We've already got hands-on with the screens, but keep an eye out next issue as we do a full review on the VX57 Series.

Of course, great bang for buck is all well and good, but how will the VX57 monitors actually help your gaming experience?

Input lag is the time it takes a monitor to display an input after receiving it. For gaming, every extra millisecond counts, so a fast input response is critical. Independent testing by **displaylag.com** shows the lag is only 10ms, which is on par or better than the VX57 Series' more expensive competition.

The VX57 Series has an excellent 1-millisecond grey-to-grey response time. The screens also use a 75Hz refresh rate, compared to the more typical 60Hz seen in most common models. This ensures the best frame rates, while maintaining a clear, smooth image, without any blurring or ghosting that could negatively impact gaming visuals.

To create a top-notch gaming experience, the ViewSonic boffins have included AMD FreeSync capabilities across the VX57 series. This tech communicates between your compatible AMD GPU and monitor to create a dynamic refresh rate that eliminates problems such as tearing and stuttering. Better yet, the VX57 monitors are some of the most affordable models to include the technology.

ALL THREE MODELS USE 1080P PANELS, WITH EXCELLENT RESPONSE TIMES AND GAMER FOCUSED FUNCTIONALITY.

Despite being affordable, the ViewSonic VX57 Series does not skimp on the inputs. For gamers, it has an HDMI and DisplayPort connection, and is perfect for connecting to both a PC and a console. The monitors even include an HDMI cable in the box. The VX57 Series also has a VGA port for total backwards compatibility with older systems. For audio, the screens feature 3.5mm input output jacks, and internal stereo speakers.

Of course, the VX57 series is also packed full of other tech and features that are important to gamers. The monitors have a comprehensive OSD, including game modes that optimise the settings for different game types. The screens also incorporate black stabilisation, which improves visibility in dark games without compromising colour performance. For those who spend long hours in front of a screen, the VX57 Series uses flicker-free backlights and is low EMI for a better viewing experience. Round the back, it even has a handy cable ring that helps eliminate tangles and clutter. *For more information visit* **au.viewsonic.com**.

SIZE: 21.5" TN PANEL
RESOLUTION: 1,920 X 1,080
RESPONSE TIME: 1MS
REFRESH RATE: 75HZ
BRIGHTNESS: 250 CD/M2
CONTRAST RATIO: 1000:1
INPUTS: HDMI, DISPLAYPORT, VGA
RRP: $169

SIZE: 23.6" TN PANEL
RESOLUTION: 1,920 X 1,080
RESPONSE TIME: 1MS
REFRESH RATE: 75HZ
BRIGHTNESS: 300 CD/M2
CONTRAST RATIO: 1000:1
INPUTS: HDMI, DISPLAYPORT, VGA
RRP: $169

SIZE: 27" TN PANEL
RESOLUTION: 1,920 X 1,080
RESPONSE TIME: 1MS
REFRESH RATE: 75HZ
BRIGHTNESS: 300 CD/M2
CONTRAST RATIO: 1200:1
INPUTS: HDMI, DISPLAYPORT, VGA
RRP: $249

GAMING HEADSET

$90 | WWW.ROCCAT.ORG

Roccat Renga

Premium performance at pocket-money pricing.

You're going to hard-pressed to find anything in the market that comes close to the quality of the Renga (is that pronouced the same as the colloquial slur for redheads?), for under $100 RRP. Even the ever-enduring SteelSeries Siberia V2 is a touch over that mark, and only if you can find it on special.

Out of the box, the Renga's materials feel (mostly) premium, and the build quality feels sturdy enough to handle a few drops. The only letdown is the wide, suspension headband – the plastics do have a sub-par, showbag-merchandise look and feel. That said, material choice was obviously influenced by weight goals, and at only 210g, the Renga is a dream on the melon.

Hanging on either end of the twin struts are massive 50mm Neodynium drivers capped with generously plush, synthetic cups. There's ventilation on the backside of the cans to keep things cool, though be mindful how much external noise open-back headphones leak. That said, the in-game sound-stage and directional targetting is top notch. There's also an omni-directional boom mic on the left side that swings down when needed.

The 2.5m cable is probably longer than needed, but we do appreciate the generosity. There's a simple inline control unit on the upper-end with the traditional volume scroll and mic mute. Roccat has also included a 3.5mm headset jack which makes it compatible with mobile, PS4 and X1 (via the Xbox One headset adapter).

A quick-release system mid-way along the cable would have been nice, too, given the cable length.

All up, a solid-sounding and great value gaming headset. ■ **Troy Coleman**

Verdict

A well-built and great-sounding gaming and mobile headset for under $100. SOLD!

WIRELESS GAMING MOUSE

$160 | WWW.ASUS.COM/AU

ASUS RoG Spatha

Huge hands required for ASUS's latest desktop beast.

The Spatha is so wide and long, it makes other mice look puny. It features the usual button cluster, customisable lighting and a tiny bit of flash storage for your profiles. A magnesium alloy chassis is to blame for all that solidity, but even the liberally-plated plastic appears to be thicker than we've come to expect. This is a wireless MMO mouse that should take some punishment.

The 2.4GHz RF connection should provide enough bandwidth for that 8,200dpi sensor, and if the battery light starts to blink, a micro-USB cable can be plugged in, so you can carry on gaming while charging. A battery capable of powering the lighting and wireless capabilities probably explains some of the size and weight here, too.

On top, the two main buttons float free from the rest of the case. ASUS claims the shape is designed with both palm- and claw-grippers in mind, but palmists might do better.

The wheel is a minor disappointment, as it's held so tightly in place. A sniper button also sits on the top of the Spatha, needing to be switched on and off, instead of held down.

The mouse sports 12 programmable buttons, six of which are under the thumb; their triangular pattern guides you toward the front two but leaves the smaller central button harder to find and push. The body's length means that, even in the hand of our specially trained mouse-testing sasquatch, moving from one button to the next requires a bit of stretching and repositioning.

It's over-engineered, but this imparts a solid precision to its movements. This is a mouse that demands to be tried. ■ **Ian Evenden**

Verdict

Solid build and precise with not too much lighting. But some buttons are hard to find, plus it's expensive.

GAMING HEADPHONES

$47 | WWW.OZONEGAMING.COM

Ozone Rage ST

A furiously low-priced gaming headset.

This gaming headset is made primarily from thick matte-black plastic, the cups are covered with spongy mesh fabric, as is the underside of the headband, and when the whole thing is sat on your head, you can hardly feel it. The lightness of the mesh fabric on the cups means that your ears shouldn't overheat either.

However, this does make it feel a bit cheap. There's no movement in the rotation angle of the cups and there's very little in the way of strength when they're clinging to your ears. On our noggin, looking up or down made the headband slide backwards or forwards a little and a slight shake of the head dislodged them completely.

Despite having no noise-cancelling abilities, when you do get round to playing some tunes or powering up the PC, the sound quality here is surprisingly good, with levels quite well-balanced. And while we've read online that some owners have experienced problems with the detachable mic, it performed fine in our tests.

The inline controller has mic on/off and volume capabilities, but it's a weird shape and at an annoyingly far location on the cable — it often got caught between our chair and the armrest. It also has no pause/play or skip buttons.

Another issue is the shape of the 3.5mm jack insulating sheath, which is square rather than circular. This meant that it had trouble fitting into smartphones using protective cases that only allow circular jacks.

But there really aren't many $47 PC gaming headsets that sound this good. ■ Carmel Sealey

Verdict

An exceptionally inexpensive headset that does the basics OK, but that's about it.

★★★½☆

apc RECOMMENDS

ADAPTER

$39 | WWW.VOLANS.COM.AU

Volans VL-HJ45

A handy adapter that proves Gigabit Ethernet and USB 3.0 are a match made in heaven.

The reliability of wired networking will always have it's advantages over Wi-Fi, but ultraportable laptops these days often just don't have the real estate for a dedicated Ethernet port. As such, investing in an adapter can be a worthwhile decision.

It's not difficult to see how an Ethernet adapter with three USB 3.0 ports is a handy tool, but we were surprised at just how accessible and convenient the VL-HJ45 made charging USB devices, performing file transfers and connecting to the internet. The body of the adapter hosts three USB 3.0 ports on the top side, so it's easy to insert and remove USB drives or peripherals and the Ethernet port sits nicely at the far end of the adapter, so the networking cable sits flat on the table. Unfortunately, there was a bit of a trade-off in USB transfer speed in our tests when compared to having them directly plugged into our MacBook: external flash drives performed 6% and 44% slower on sequential read and write tests, respectively, and the write speeds of smaller files showed similar shortfalls.

When it comes to networking throughput speeds, though, there's little compromise, with the Ethernet port pushing an average of 448Mbps up and 533Mbps down across a local network using the TamoSoft Throughput test. That's about the same as we see in native Ethernet adapters and five times the fastest NBN internet speeds. In other words, it has more than enough grunt to handle anything except maybe a seriously souped-up local server... and even then, this one's still plenty fast. ■ Joel Burgess

Verdict

A well-built USB 3.0 multi-adapter that's great for laptops that are lacking USB and Ethernet ports.

★★★★☆

software

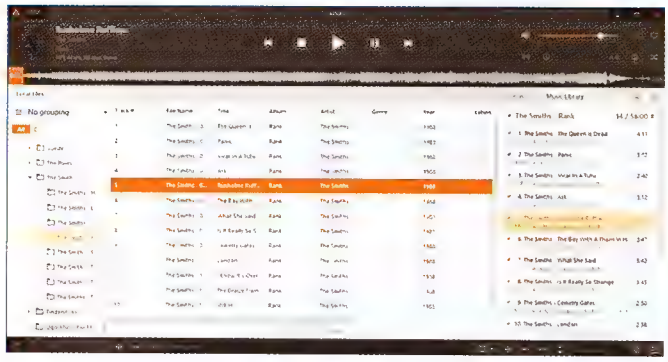
» APPS FOR ALL THE PLATFORMS

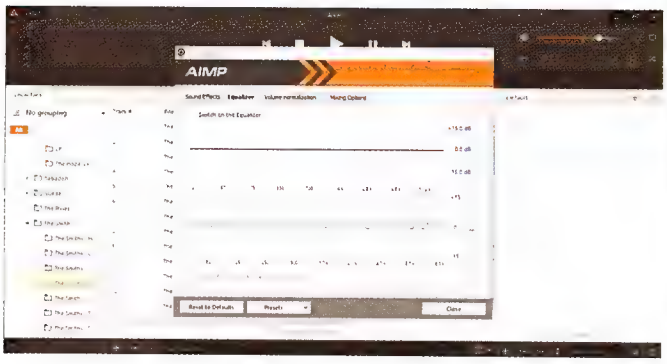
Windows SOFTWARE

AIMP

An extremely versatile music player with smart playlists, effects and internet radio.

FREE | WWW.AIMP.RU





Calling AIMP a music player would be doing it a disservice. As well as playing music, this app also acts as an audio organiser, making it easy to change MP3 tags and create playlists. This can be done manually or by creating smart playlists to match a mood with less effort. The program can also be used to listen to streaming internet radio stations, can function as an alarm clock, audio converter and more.

AIMP has a fairly unique look – almost like a blend between a Mac and Linux app, and while this might sound off-putting, it works. Once you have music playing, AIMP has an interesting way of minimising out of view. Rather than disappearing into a taskbar button, the program window disappears completely and can be accessed through a tiny tab that appears at the left of the screen when the mouse is moved near to it.

Basic playback options and playlisting are easy to use, and the audio converter, which handles a highly impressive number of formats, is a breeze to get into.

What's most impressive about AIMP is the level of control it gives you, and not just in terms of organisation. The DSP Manager includes an impressive 18-band graphic equaliser, and there's a range of sound effects that can be applied to music during playback. You can also tinker with speed, tempo and pitch settings. The timed shutdown and alarm clock function are handy additions, too, as is support for an almost unparalleled number of audio formats.

There's not really much to dislike about AIMP. If there's any criticism to be levelled at it, it would be that the Options screen is something of a mess. There's a huge number of options and preferences that you can configure, and that means having to work through an awful lot of sections. So things could perhaps have been better organised.

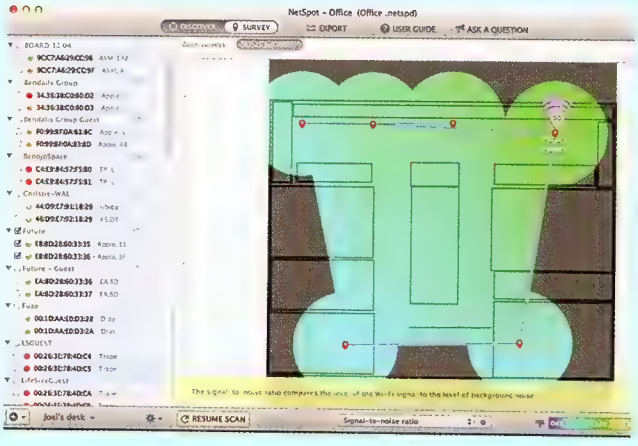
You might think that you're happy with your current media player, but that's probably just because you don't know what you're missing out on. Give AIMP a whirl.

Mark Wilson

NetSpot

VISUALISE YOUR HOME WI-FI STRENGTH.

FREE, PRO $149 | WWW.NETSPOTAPP.COM



There are a number of Wi-Fi signal strength apps out there, but most of them are free applications that don't really have the scope to be relied upon in a professional capacity.

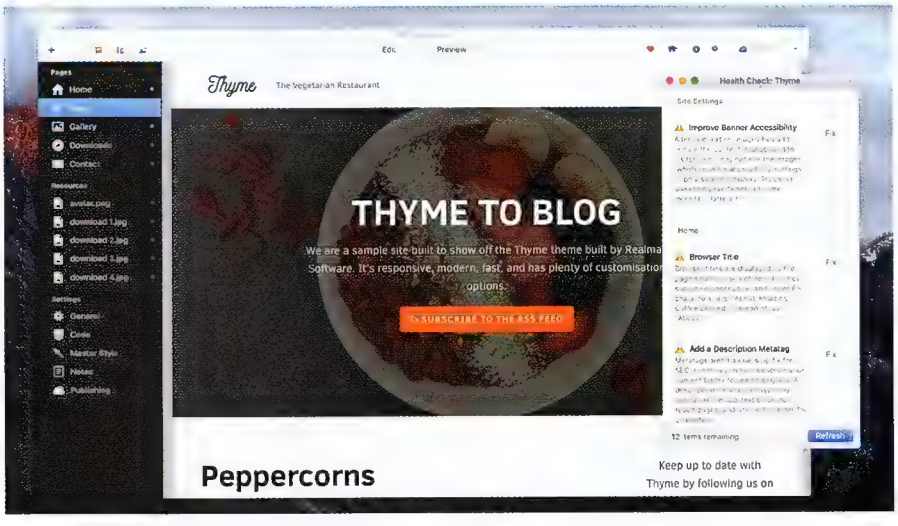
If you're looking for something a little more in-depth, or you happen to want a heat map of the Wi-Fi signal strength in your home, office or other venue, then NetSpot is about the only free software that can do it. The application is broken up into two main modes: a discover section that works the same way as traditional signal detection software, and a survey section that allows you to build a Wi-Fi signal strength map over the top of an imported floorplan, or one you've drawn yourself using the app. Though you'll only get basic information like the signal strength and level of Wi-Fi noise in the area if you use the unpaid application, the Pro tier will net you access to the download and upload speeds of each location using the various internet protocols and a few additional mapping perks. **Joel Burgess**

RapidWeaver 7

Craft impressive websites with a minimum of fuss.

US$99 | REALMACSOFTWARE.COM

RapidWeaver may be the most Apple-y app that Apple doesn't actually make. While it's much more powerful than Apple's long-defunct iWeb, it shares that app's ease of use. And Version 7 doesn't mess with the formula too much, bringing some welcome improvements without radically changing how it works.



The app is built around professionally-designed themes, with four new ones added to the existing collection in this release. You use the sidebar to create the structure of your site, the Edit panel to modify pages, the Preview pane to see what it looks like, and there's a Keynote-esque Master Style for making global changes to your chosen template. You can also add custom code such as CSS, JavaScript and meta tags. It's all very easy, enabling you to build a great website in very little time, regardless of your level of experience.

This version boasts a dramatically improved FTP client for uploads and site management, FTP path browsing, the ability to publish the same site to multiple locations, a Publish Locally option, and the ability to move your project across multiple Macs (the licence covers you for two). The app now optimises CSS and JavaScript code to make it as clean and as quick as possible, and it also includes an SEO Health Check that can help make your site more Google-friendly.

The app is also expandable through more than 1,000 add-ons. These cost money, which has caused some grumbling on the internet, but when you consider the effort that goes into making a decent theme or shopping cart app, the average asking price range of around US$30 (about $40) is hardly daylight robbery. The available options cover every conceivable category, from image galleries to shopping carts, audio embedding to typography, adjusting your backgrounds, and much more. The only thing RapidWeaver isn't too keen on is you creating your own site designs.

If you just need to put together something quick and simple for a small organisation or yourself, the rival app Sandvox is a great option, but if you think you'll need something a bit more ambitious, RapidWeaver is flexible enough to meet your future needs, as well as today's. **Gary Marshall**

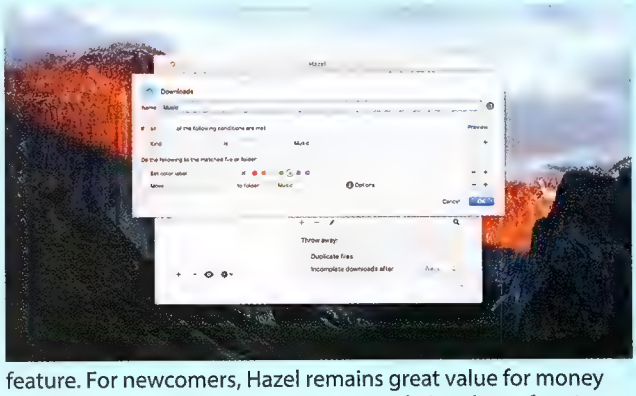
Hazel 4

Keep your Mac tidy... automatically!

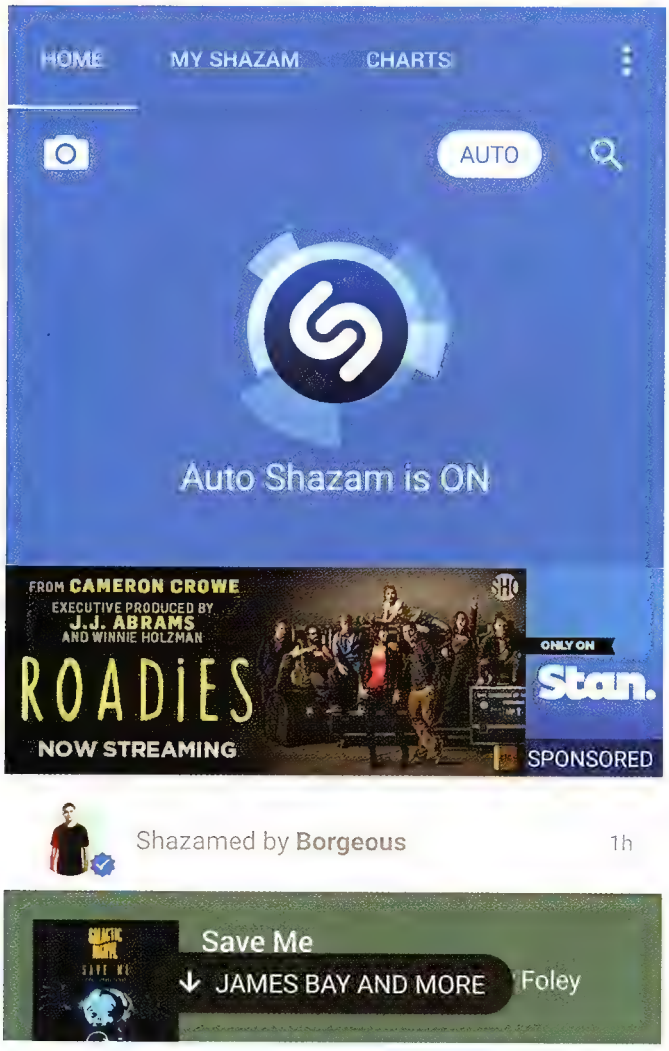
US$32 (US$10 UPGRADE) | NOODLESOFT.COM

Hazel serves as a housekeeper for your Mac, tidying and organising your files. Its rules system will be a familiar concept if you've ever experimented with Finder's Smart Folders. You set up conditions and specify what should happen to matched items. By making use of carefully-constructed, multicondition rules, you can come up with surprisingly complex actions, even going so far as to import content into apps, or archive or upload items. For example, if you regularly dump things on your Mac's desktop, Hazel can monitor documents for keywords and periodically move matching ones somewhere safe.

Construction of rules is now simplified somewhat through being able to preview them and discover where they fail. This update also adds the abilities to search rules and sync them between Macs. Frankly, we'd have paid just for the preview feature. For newcomers, Hazel remains great value for money due to how much time it can save, even if it's only performing the most basic and tedious of tidy-up tasks. After all, that's one less job for you.



Craig Grannell



Shazam

Never not know that tune.

FREE | WWW.SHAZAM.COM

Shazam was one of the first 'wow' apps for smartphones, because it worked like magic: at the press of a button, it identified any song, save your brother's pots-and-pans-led acoustic improvisation trio.

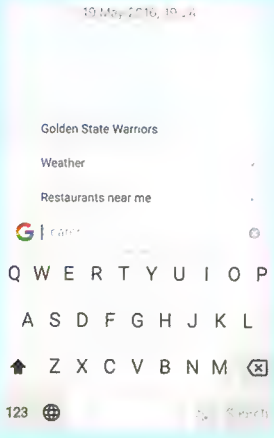
Gone are the days when you'd hear a song on the radio or at the pub and spend weeks trying to identify it, because Shazam made it easy. It's worth revisiting now, because a recent update introduced an auto-Shazam function, which is especially useful if you're in the habit of seeing a lot of DJs or going to a lot of clubs. It'll basically create a list of each song played during the period that it's active, and this list is archived so that you can source all of the music while you're nursing a hangover the next day. Sure, it completely neuters the thrill of the chase, but with auto-Shazam, you'll basically never have a reason not to chase up a great track again. **Shaun Prescott**

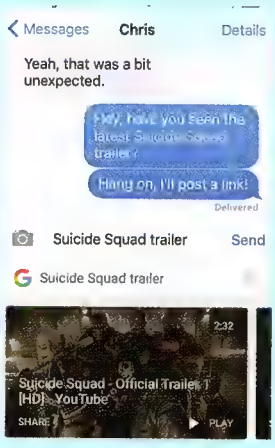
Gboard

Combining keyboard with Google Search

TINYURL.COM/APC432-GBOARD | FREE

So you're trying to meet up with a friend for breakfast but you can't remember the address of this great café you want to go to. You exit your messaging app, hop online, do a quick Google search, find the address after a bit of scrolling, copy it, return to your messaging app, paste, send, mop sweat off brow. We do this sort of thing quite often — so often, in fact, that Google has created Gboard, a special keyboard that integrates Google Search right within whichever app you happen to be using. No switching around required. The G icon appears in the top left of the keyboard. Hitting this opens Search. You type into the search field and the results pop up right there, be it websites, trailers, emojis or GIFs. It incorporates glide typing, as well. This service has only recently become available to Australians, with Google working on something similar for Android users for the future. This app looks to be a valuable time-saver. **Carmel Sealey**





Gogobot

Places to stay, things to do...

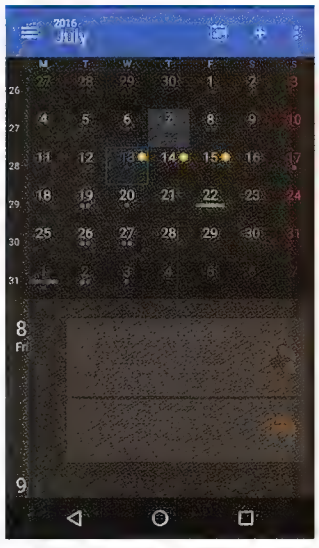
WWW.GOGOBOT.COM | FREE

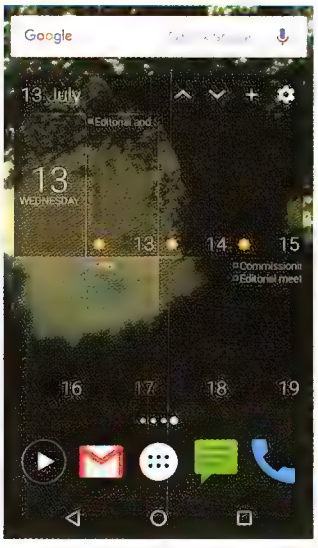
I've never been part of a tribe before, but now I'm part of five, according to Gogobot. Tribes are actually interests and feed into the suggested places and activities section — For You. You can log in using your email address or social media profile and start getting Gogobot set up for your personal needs. It detects your location and immediately goes about suggesting breakfast, lunch or dinner locations (depending on the time of day — coffee is all day, surprise surprise), weekend getaways and then activities based on your Tribes — history, backpacking, night life, business, families, foodies... You can write reviews of places you've been, take photographs and add them to the community — actions that reward you with points that elevate your status on the world leaderboards, if you're interested in gamifying your life a bit more. The app will also cater to whether you're local or a tourist, suggesting some of the local dining favourites for tourists to truly experience the culture and also pointing out the not-to-miss attractions. **Carmel Sealey**

DigiCal Calendar

Your new default organiser.

FREE | WWW.DIGIBITES.NL/DIGICAL





It's no secret that Android's default calendar option is a bit disappointing: some say it's ugly, while others think it lacks certain crucial features.

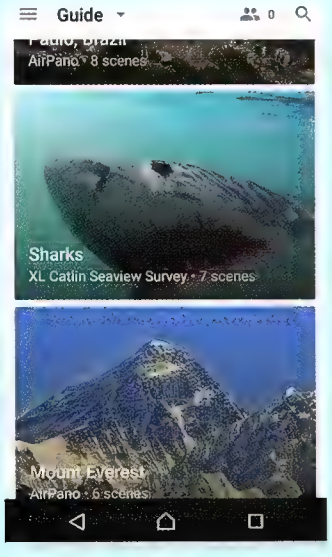
These common opinions are why there is a flood of replacement apps on the Google Play store, and it's difficult to get a handle on which are good and which are pure evil. DigiCal Calendar is definitely one of the good ones: it taps into Google Calendar, Outlook and Exchange, as well as weather and public holiday data, but its real benefit is aesthetics. The widgets here are much sleeker and – most importantly – more detailed than the competition. The thing is, most of the really lovely ones are locked behind a paywall, all of which can be accessed for $4.95. That isn't too bad if you expect to be looking at one of the selections for the next couple of years.

Shaun Prescott

Google Expeditions

FREE | WWW.GOOGLE.COM.AU/EDU/EXPEDITIONS

Got a horde of cooped-up kids in your care who are looking for adventure but are treacherously house-bound? Google Expeditions might be the escape they (and you) are looking for. This virtual reality app has tours of sites and scenes from natural history (sharks, Mount Everest) to popular TV shows (*Doctor Who* and *Mythbusters*) and plenty of landmarks in between. One person leads the tour, and the rest — armed with Google Cardboard viewers and the app on a phone — follow. Each locale is broken down into scenes with a handy script for the leader to read out, with multiple points of interest in each, and the followers are free to look around as they wish, though their gaze will be directed to the highlighted item. There are dozens of places to explore, and while a lot are pitched towards Americans, you'll find plenty of others with a broader interest. You will all need a phone and the followers need a viewer each, and make sure you're connected to the same Wi-Fi network.



Paul Taylor

BitTorrent Now

FREE, IAP | BUNDLE.MEDIA

The name BitTorrent is a familiar one to most Australians. Without any input or momentum of its own accord, the peer-to-peer download client has become synonymous with piracy, be it of software, music or movie files. The company is forging ahead with plans to be legitimate, however, and BitTorrent Now is more concerned with being a platform for artists — be it musical, visual or filmic — to share their work in a fair and often free manner.

You'll find some well established artists, like Madonna, mingled in with underground and independent groups you've probably never heard of. Jumping in, then, is a bit like tumbling into a lucky dip, though we found some excellent covers and remixes of songs by the Rolling Stones, and a track that brought Crosby, Stills & Nash into the 21st Century.

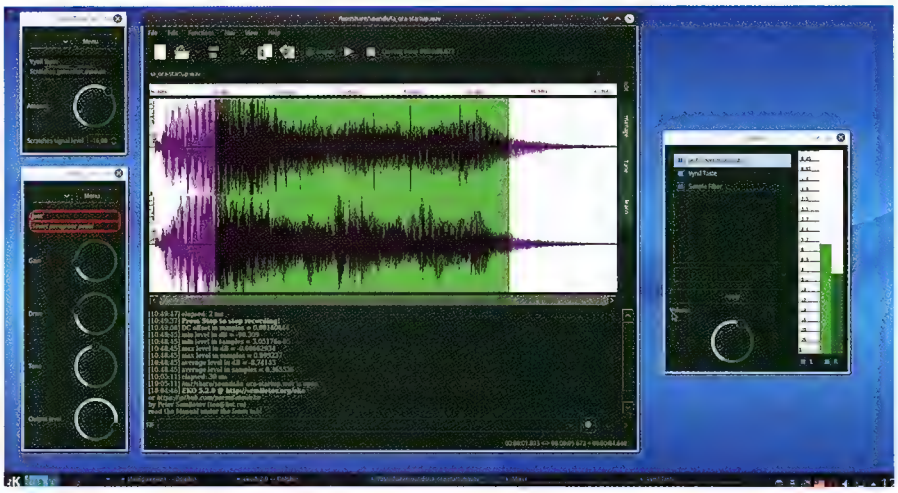
Neil Young- Old Man (Marvel Ye...
MARVEL YEARS
FOLLOW
This is the entire collection of Marvel Years music as of 8/11/15. Get it all in one easy download! This includes originals, remixes, mashups, mixes, and eps. Enjoy! :)
FAVORITED
SHARE BUNDLE

BitTorrent Now is primarily a streaming service, though there are links to download packages as you see fit. It's stylish, albeit a little rough to get what you want. **Paul Taylor**

Eko

Sound wave editor.

FREE | SEMILETOV.ORG/EKO



Eko recently hit version 5.20, yet there are very few people that have ever heard of this small but very useful application. We think that Eko has received very little attention considering what it manages to achieve as a one-man project, but it's worth taking a closer look at it.

Eko may look minimalistic and sometimes resemble simple wave editors, such as KWave, but there are many features with some extras that you will not find even in Audacity. It's best to start exploring Eko from its Functions menu, which includes silence and noise generators, fade in/fade out feature, wave normaliser and offset editor. By default, Eko opens the extra Mixer window, where you can apply versatile effects on top of your recording or loaded file. Those who are keen on home recording will also appreciate the guitar overdrive pedal and retro vinyl effect. Each effect has its own Settings panel where you can adjust its amount, tone, level or resonance, depending on what each effect is about. You can mix several effects and sort them to your liking.

Eko has a convenient user interface that fits a lot of information into limited space. You can open more than one file at a time and switch between files as you do with tabs in a web browser. There's also a handy vertical bar to the right of the main wave area. The tabs there enable you to go to Eko's settings (Tune), browse the filesystem and save/rename files (Manage) or consult the built-in help manual (Learn). Eko doesn't have any problems with capturing sound either, because it follows your desktop-wide PulseAudio settings, but you can still set custom input/output devices at 'Tune > Sound Devices'.

Surprisingly, the project website only offers a Windows build, but there are Eko builds available in many distributions' (distros) extra repositories (repos), such as Arch Linux and OpenSUSE. If you're missing your copy, feel free to build Eko from source, it's as simple as `$ qmake && make && sudo make install` .

Alexander Tolstoy

Synapse

FREE | BIT.LY/SYNAPSEPROJECT

Synapse is a launcher and a search field provider with a rich set of features. It offers a semantic search capability by using the Zeitgeist engine, written in Vala programming language. Using Synapse, you can fire up applications quickly; find and access documents; locate files/folders; and it offers quick access. You can launch Synapse using Ctrl-Space. Using left/right arrow keys, you can navigate between different categories to enhance your search or you can extend your search using the down key.

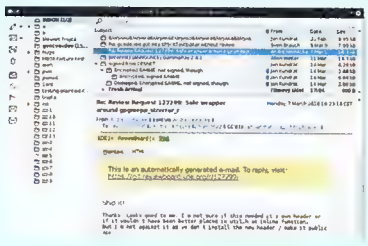
The key strength of Synapse is its universal approach to different entities from one point. Look through the plug-in list in 'Preferences > Plugins' and you'll find that Synapse has a lot of connectors, including Launchpad bugs, Chromium bookmarks and Jabber chat history. If you install Synapse for the first time, it will return limited search results because very few events have occurred and have been logged by Zeigeist. Once you start using the system for longer, the search will be made much better by Synapse. **Alexander Tolstoy**

Trojitá

FREE | TROJITA.FLASKA.NET

This is a light Qt5-based email software with a focus on high performance, particularly when it comes to working with several mailboxes at once. Trojitá is specifically designed to work with the IMAP protocol, which is widely used everywhere. You can set up Trojitá to use any sort of IMAP-based email service, be it an in-office corporate mailbox or a public service (like Gmail). Due to the way IMAP works, you can customise the offline mode in Trojitá and tell it, for instance, how long it should keep downloaded messages in its cache. The application also provides three modes for connectivity and respects your budget if you pay for each megabyte. The latest Trojitá 0.7 brings various GUI refinements, as well as many bug fixes to the application's internals. The most visible new feature in this release is perhaps the support for OpenPGP/GPG/S-MIME/CMS/X.509 signatures. Trojitá can now verify and decrypt such emails seamlessly. The ability to sign new emails with such signatures is a proposed future feature.

Alexander Tolstoy



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NAS BOXES + HDDs, EXTERNAL + PORTABLE USB DRIVES & BUDGET SSDs COMPARED! PLUS COMPLETE GUIDES TO WINDOWS & MAC BACKUPS!

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Sometimes, capacity is more important than portability.

78 WIRELESS HARD DRIVES
Portable NAS drives under the microscope.

Make flawless Windows backups

Protect your precious data from any disaster with our essential advice

Backups may not be the most glamorous of subjects, but they're worth paying attention to. Think about what your data is worth. Some files are more valuable than others – it could be a matter of the time taken to create a document, while other files, such as photos hold sentimental worth.

Most people know the importance of backing up, but can you be sure your backup plan is up to scratch? Many people keep one backup copy of their files, but what happens if it is destroyed along with the original? Seeing as most people keep their backup drive in the same location as their PC, that's not a fanciful notion.

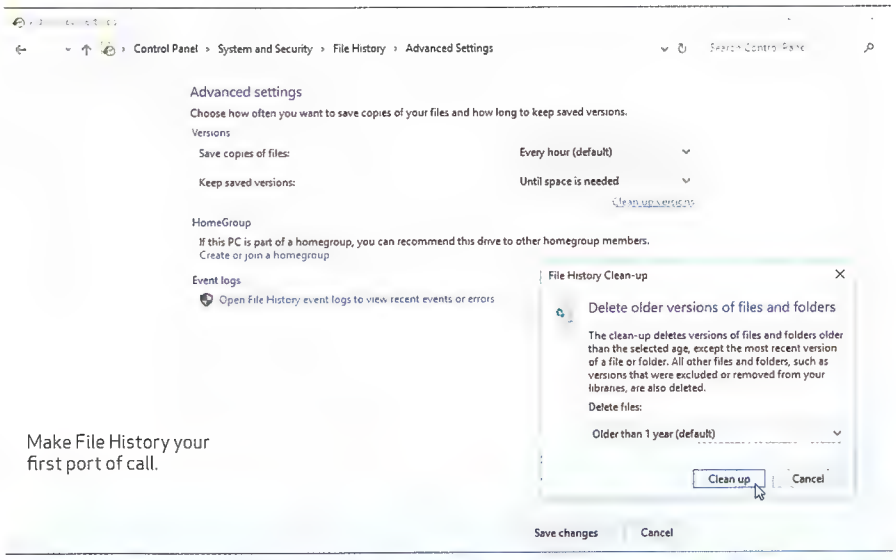
We'll help you create a multi-layered backup of your data, ensuring it's stored in at least two separate locations, preferably more. We'll reveal the best tools to use – both Windows' own backup tools, as well as great third party tools. We'll also look at backing up your entire system drive, so if you run into problems, you can roll back to a working Windows installation without having to reinstall.

These days, keeping at least one backup in a remote location usually means taking advantage of cloud-based services, such as Dropbox or Microsoft OneDrive. There are many potential issues with relying on third parties, whether it's security, constantly changing pricing plans, or what happens to your data if the company ceases trading. If these are deal-breakers, we'll look into alternatives, from sharing backup space with family members to setting up your own encrypted cloud storage, where you have no worries about subscriptions.

We'll also make sure you know what to do should disaster strike and you need to restore a copy of your data.

You may already have a basic backup plan in place – Windows 10 makes this easy by offering you two routes, including both 'Backup and Restore' from Windows 7, and 'File History' from Windows 8. They're easy to access and set up – search the Start menu or Cortana for 'backup'. Both focus on producing backups of key documents, photos and other data, and can back up to any drive that's visible to your PC, including network-attached storage.

Rule one of our backup strategy is to make use of multiple backup locations (see 'Select your backup device', below-right). Neither 'File History' nor 'Backup and Restore' allow you to back up to alternate locations, but if you're running Windows 10, you can employ both together to get around this restriction. Configure 'File History' to back up to one location – we recommend a drive physically attached to your PC – and use 'Backup and Restore' to back up to another drive, preferably a shared folder on your network drive. 'File History' constantly monitors for changes and backs up as necessary, while you should schedule 'Backup and Restore' to run weekly at a time that won't interfere with PC use.


Control Panel › System and Security › File History › Advanced Settings
Advanced settings
Choose how often you want to save copies of your files and how long to keep saved versions.
Versions
Save copies of files:
Every hour (default)
Keep saved versions:
Until space is needed
HomeGroup
If this PC is part of a homegroup, you can recommend this drive to other homegroup members.
Create or join a homegroup
Event logs
Open File History event logs to view recent events or errors
File History Clean-up
Delete older versions of files and folders
The clean-up deletes versions of files and folders older than the selected age, except the most recent version of a file or folder. All other files and folders, such as versions that were excluded or removed from your libraries, are also deleted.
Delete files:
Older than 1 year (default)
Clean up
Cancel
Save changes
Cancel
Make File History your first port of call.

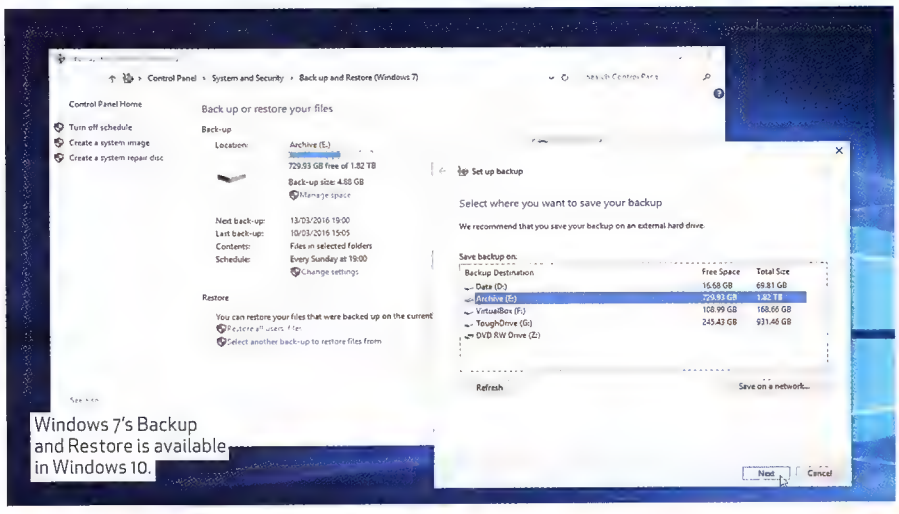
SYSTEM BACKUPS

Your data is taken care of, but what about Windows itself? If disaster strikes, you could find yourself spending days getting your PC set up again – but if you take a full system backup (known as a 'drive image'), you can have your PC up and running again within an hour.

Windows offers to create a system image when you set up 'Backup and Restore', but there are weaknesses. First, each backup requires tens of gigabytes of space on your PC. Second, images aren't verified when they're created, so you've no way of knowing if you can rely on them. And third, images are only stored on a single drive.

Eliminate all three weaknesses by employing the services of our favourite drive-imaging tool, Macrium Reflect. We've used it to back up (and rescue) Windows countless times over the past five years, and nothing comes close to it. Start with the powerful Free version at **www.macrium.com/reflectfree.asp**, which solves the issue with space by using differential images that take up much less room by only recording the changes made since the last backup was taken.

Launch Macrium Reflect Free once installed, and click 'Create an image of the partition(s) required to backup and restore Windows'. Next, set your destination – a folder on your backup drive. You might want to change the file name to something more easily recognisable, and take the time to click 'Advanced Options' to select 'Auto



Windows 7's Backup and Restore is available in Windows 10.

Select your backup device

When it comes to choosing where to back up your files to, you're spoiled for choice. But it's not a case of either this backup device or that one – ideally you should invest in at least two separate devices. Look for the following:

Secondary hard drive: this can be internal or external (USB). Use it for your primary file and drive image backups, using Windows' own tools and Macrium Reflect Free.

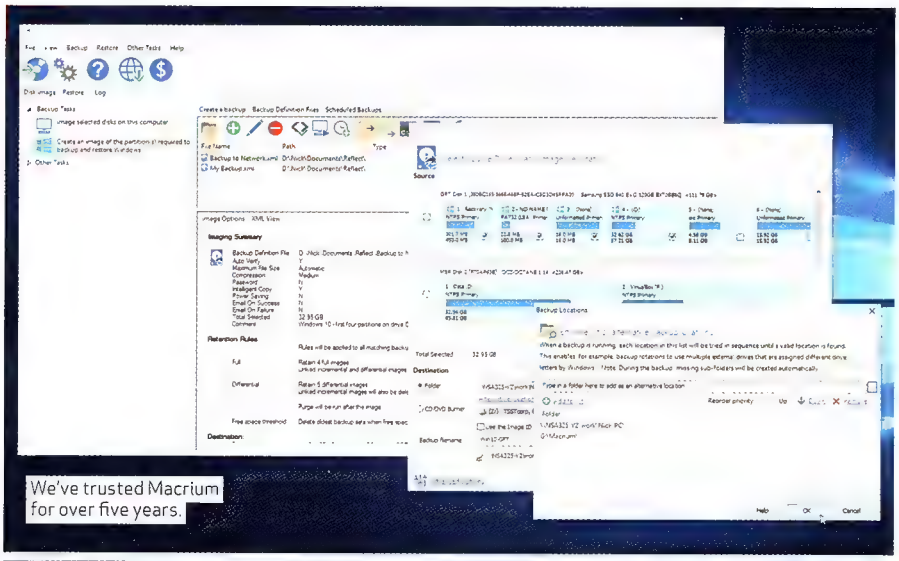
Network hard drive: a good secondary solution that can be kept elsewhere in your home for added security. Perfect for any of the backup methods we discuss here – you can even use it as the basis for your own personal cloud storage system using OwnCloud.

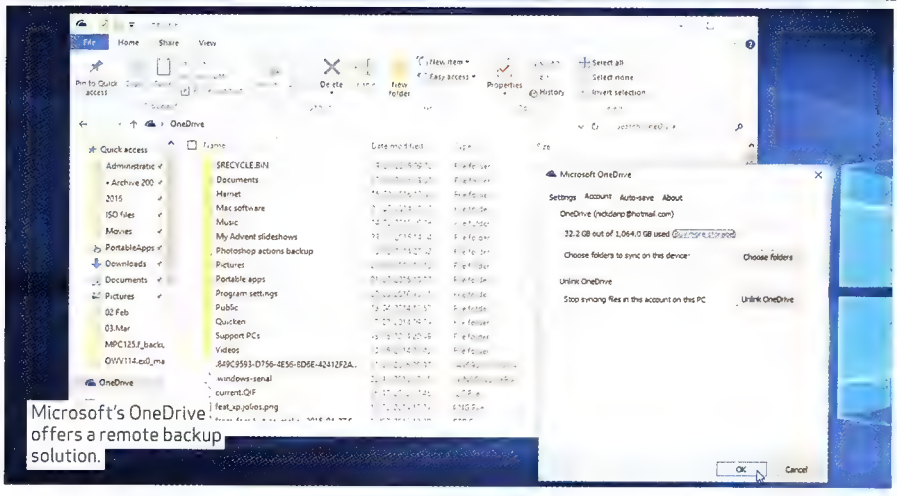
Other computer: if you own another PC (or Mac), keep your key files in sync on all your computers using a cloud storage service or Syncthing. As an added bonus, the latest version of your data is always available to whichever PC you're using.

Friend's or family computer: you can swap unused storage space with people you trust, but make sure your data is kept in an encrypted format on their computer – use Buddy Backup or Viivo in conjunction with Syncthing.

Cloud storage: if you have a fast, unlimited internet connection, using a trusted service, such as Dropbox, Microsoft OneDrive, or Google Drive is also an option. Again, use Viivo to encrypt sensitive data for extra security.

Synology's DS216+ network drive is a great backup device.


We've trusted Macrium for over five years.


Microsoft's OneDrive offers a remote backup solution.

Verify Image' to ensure your backup is checked for errors after it's been taken. Once done, pick a backup schedule – we recommended pairing one monthly full backup with weekly differential backups, or choosing the 'Differential Backup Set' template for more frequent daily backups. Click 'Next' followed by 'Finish'.

In the spirit of data redundancy, you should then repeat the process, creating a second definition rule pointing toward your secondary backup drive – speed things up by right-clicking the rule you just created and choosing 'Duplicate'. Don't forget to create the rescue media (DVD or 4GB USB flash drive) when prompted by Macrium – this ensures you'll be able to restore your system even if Windows won't boot.

If you want more features – including incremental backups, and the ability to back up files and folders – upgrade to Macrium Reflect Home Edition.

THE POWER OF THE CLOUD

These days, backups are synonymous with the word 'cloud', the logic being that storing backups in the cloud ensures one copy of your data is kept off-site in a secure location in case of fire, theft or worse. It makes sense, although there are some drawbacks. The obvious choice when backing up to the cloud is to employ a known solution – Microsoft's OneDrive service is baked into Windows 10, but alternate trusted sources include Dropbox (**www.dropbox.com**) and Google Drive (**drive.google.com**).

Each service offers limited free plans of around 5–15GB of free storage space, which is fine for personal files, such as documents, photos and even some video, but if you run out of space, you'll need to upgrade to a monthly or annual subscription. One of the best value solutions is to install Office 365 – your subscription includes 1TB of cloud storage and access to the latest version of Microsoft Office for up to five users.

However, there are some reasons to treat cloud storage with suspicion. These include ongoing costs, the security of your data, and what happens if the company in question either goes out of business or discontinues its product, as users of Wuala and AVG LiveKive cloud storage services have discovered to their cost over the years.

In terms of fees, consider prioritising what data you store in the cloud – do you need your videos backed up online, for example? As you have a local backup in place, you could focus on storing important documents and photos in the cloud, where you're unlikely to run out of space quickly. That way, you can usually get away with free storage plans.

If you don't trust your cloud provider's encryption, add a secondary layer of encryption to sensitive files before uploading them to the cloud. The best tool for this purpose is Viivo (**viivo.com**), which works with multiple cloud providers, and includes tools for sharing access to files with family and friends. It's free for personal use, but make sure you keep a separate, unencrypted backup of this data somewhere safe, too, to ensure you're not locked out of your files.

ALTERNATE STRATEGIES

There are two main alternatives to putting your data in the hands of a third-party provider. Both can be used over the internet if you have a fast and unmetered connection, but you can also use them exclusively over your local network, too, ensuring your data never touches the cloud in any shape or form.

The first of these options involves syncing data from selected folders directly between two or more computers. It works over your local network, as well as the wider internet, if necessary. It's perfect for keeping files in sync between computers you own, and creates a copy of your files, so there are no issues with proprietary file formats. Naturally, the connection is encrypted, and the software is open-source.

The program in question is called Syncthing and it works across Windows, Linux and Mac, and can even be directly installed to selected network drives. We recommend installing the GTK build from **github.com/syncthing/syncthing-gtk** – install it on both computers, then select the folder you wish to sync on your main computer, before connecting it and your other PC together. Once done, the files are kept in sync automatically whenever Syncthing runs – configure it to start with Windows, to ensure it's always backing up.

Files are transferred directly between computers, so they both need to be on and connected for files to sync. If you wanted to store backups remotely on other PCs, take a look at BuddyBackup (**www.buddybackup.com**), which encrypts your data so it's unreadable on the computers you back it up to.

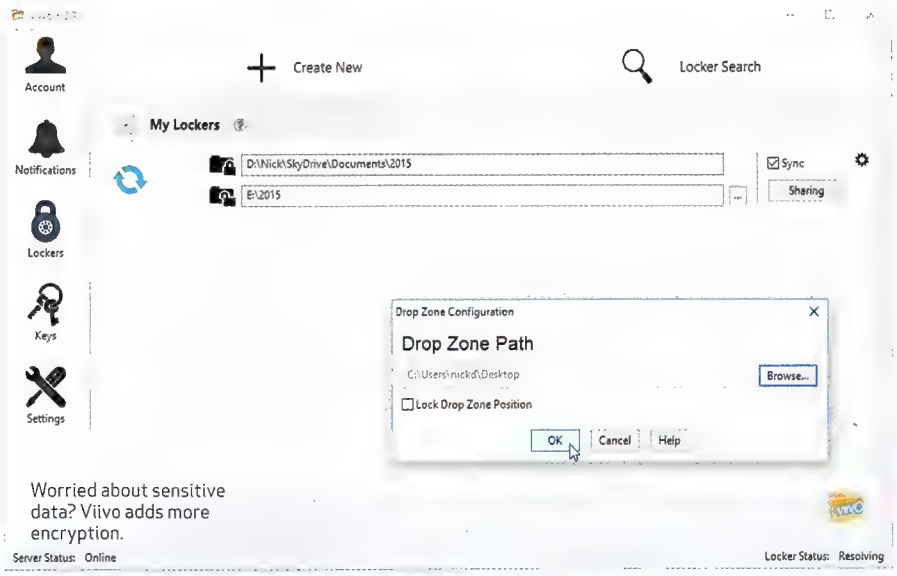
YOUR PERSONAL CLOUD

If you'd like to store files centrally (creating an additional backup of your files in the process), without relying on a third party, then set up your own using a spare PC or network hard drive as the file server.

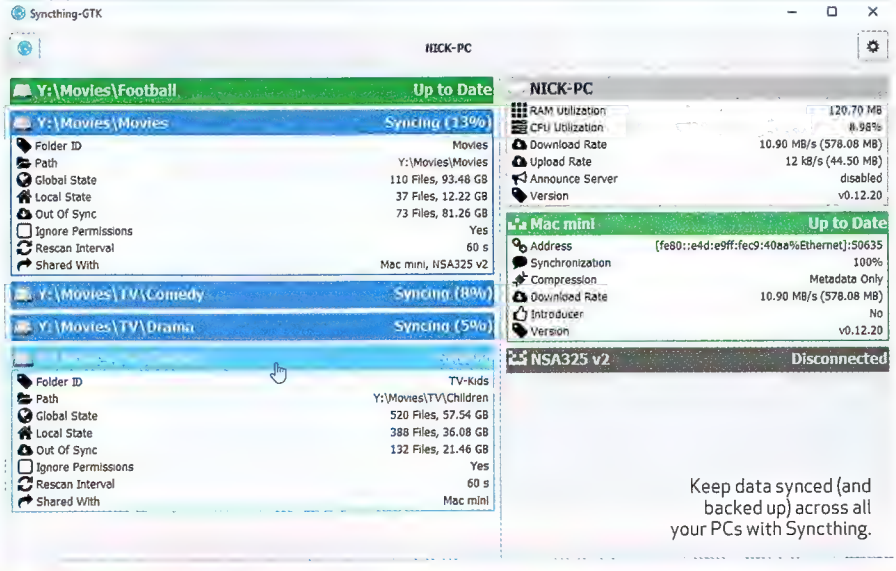
Some network drives come with their own proprietary cloud systems – My Cloud from Western Digital, for example – but we recommend choosing something open source and more widely supported – OwnCloud (**owncloud.org**), which works across a variety of platforms. The server part can be installed to many network drives – including Zyxel and Synology (the latter via **synocommunity.com**) – as well as Linux-powered PCs, including the Raspberry Pi 2, if you're looking for a low-cost solution. You then download and install the desktop and mobile clients on Windows, Mac, Linux, Android, iOS and other supported platforms, to allow you to both sync and access your files from anywhere.

Think of OwnCloud as being your own personal cloud storage system – you're not tied to any third parties, there are no fees, and your cloud can be restricted to your local network or opened up for access over the internet. It works with multiple users, too.

Some initial configuration is required, but everything's point-and-click, with a useful manual on hand to steer you in the right direction. When asked to set up your initial account, be sure to click 'Storage & database' and select the 'MySQL' option, rather than the default 'SQLite' one. This will dramatically speed up the



Worried about sensitive data? Viivo adds more encryption.



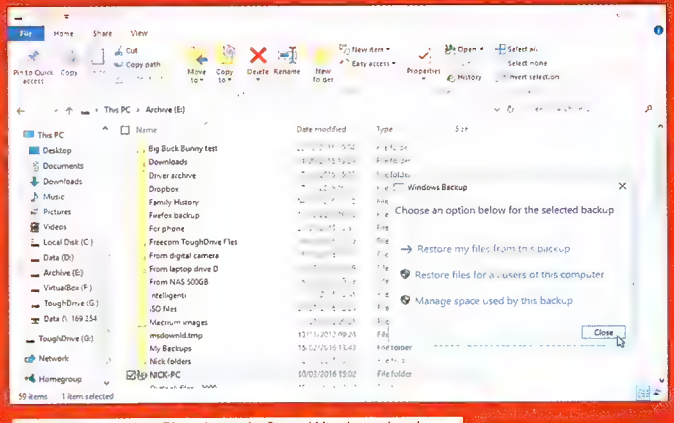
Keep data synced (and backed up) across all your PCs with Syncthing.

Protect your backups

Nothing lasts forever — and the same is true of backups. Optical discs don't last a lifetime, while hard drives wear out, and cloud storage can disappear without warning. That's why backing up to multiple locations is essential, but it doesn't stop there. You should take additional steps to protect your data from physical degradation.

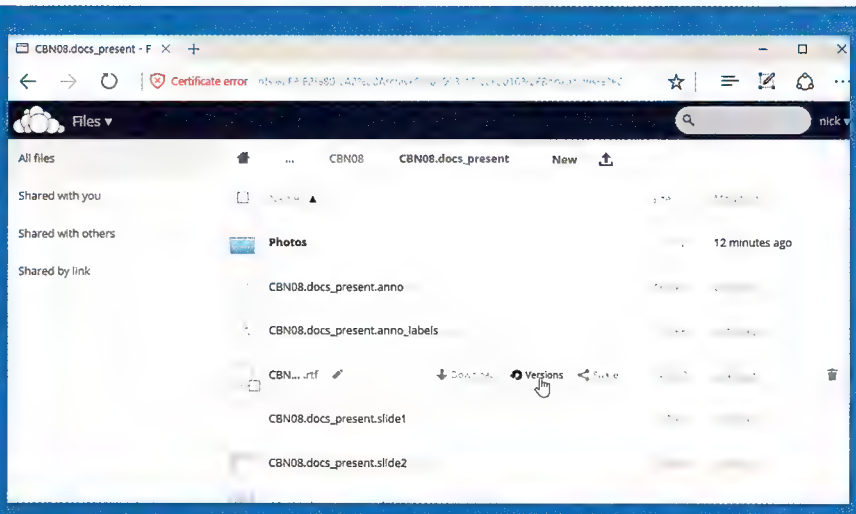
Check with the maker of your drive for a monitoring tool, such as Seagate's SeaTools (**www.seagate.com/seatools**), to keep an eye on your drives' health, giving you time to replace failing drives before they disappear with your data. If you want a network drive, choose a two-bay model, such as Synology's DiskStation 216+ and fill it with two identical drives in a RAID 1 setup. Data is mirrored on both drives, so if one fails, you can swap it out with a replacement without fear of data loss. Just remember a RAID array doesn't constitute two backups — if the enclosure fries (or gets stolen), you lose both drives. (As an aside, try the free DMDE data recovery tool from **www.dmde.com** if you need to recover data from NAS-formatted drives.)

Also watch the software you use. Some tools store your data in their own proprietary formats, so if the software stops working (perhaps after upgrading to an unsupported version of Windows), you lose access to your backup. Both Windows backup tools use their own format, as does Macrium, Backup Buddy and Viivo (as part of protecting backups through encryption).


Windows Backup
Choose an option below for the selected backup
Restore my files from this backup
Restore files for all users of this computer
Manage space used by this backup
Close

You can't recover files directly from Windows backups.

So make sure one of your backup plans duplicates your files in their original format to ensure you have one easily recoverable version of your files.



Back up file revisions

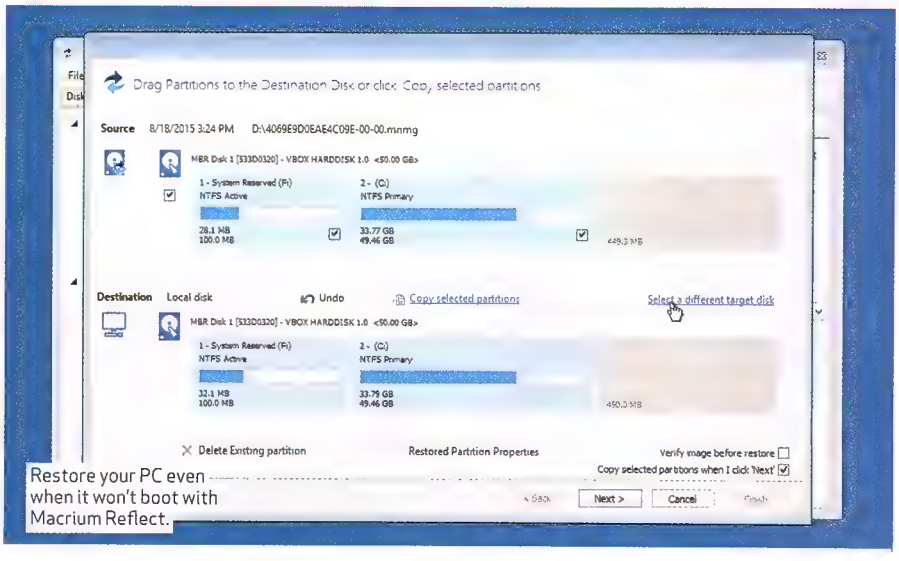
One of the benefits of following our backup plan is many of the tools on offer record multiple versions of your files, enabling you to undo changes to files as well as restore lost, deleted or corrupt data. Both Windows backup tools support this, although File History's default settings of updating your files every hour (rather than weekly, as with the Backup and Restore tool) gives greater flexibility.

If you back up files to OneDrive, Dropbox or your own OwnCloud server, access your account through your web browser, then locate the file in question. OwnCloud users should click the 'Versions' option next to the filename; otherwise, right-click the file and choose the option to restore a previous version, to see what's available based on time and date. You can preview earlier revisions by clicking them.

Syncthing only stores one revision of a file by default, but you can change this on a folder-by-folder basis. Right-click the folder bar in Syncthing-GTK and choose 'Edit', then select an option from the 'File Versioning' menu — each has a description, and you get context-sensitive options, such as the number of versions to keep.

One caveat: storing multiple versions of files requires more space than straight one-to-one backups. Bear this in mind when choosing what size hard drive to buy.

"Disaster has struck — you've lost data, so what next? Thanks to your backup plan, you should find you're able to restore the data you lost."



Restore your PC even when it won't boot with Macrium Reflect.

server's performance when it comes to syncing large batches of files.

RESTORING FROM BACKUPS

Disaster has struck — you've lost data, so what next? Thanks to your backup plan, you should find you're able to restore the data you lost. If you've used 'File History', navigate to the folder with the missing data in File Explorer and click the 'History' button on the 'File' tab. A window opens displaying all the backed-up files in that folder — double-click the missing file to preview it, then click the 'Settings' button and choose 'Restore' to save it to the current location, or 'Restore to' to save it elsewhere. If you're trying to recover an earlier version of a file, use the left and right buttons at the bottom of the page to navigate between available versions.

If you're recovering from 'Backup and Restore', browse to the drive or folder containing your backup, then double-click it and choose 'Restore my files from this backup'. Click 'Choose a different date' if you're looking for older versions of your files, or use the search and browse buttons to locate what you want to restore. You can restore them to their original location, or choose another — make sure you leave 'Restore the files to their original subfolders' ticked, before clicking 'Restore'.

Need to recover your entire PC? Macrium Reflect makes things straightforward. If you can boot into Windows, launch the app and switch to the 'Restore' tab; otherwise, boot from your rescue media. Select the backup you want to roll back to from the list given, or click 'Browse for an image file' to locate it manually. Select 'Restore Image' to restore the image, or choose 'Browse Image' to mount the image as a virtual drive, enabling you to browse it as a virtual drive in Windows itself — a good option for recovering individual files and folders from the backup. Tick 'Enable access to restricted folders' to allow you to recover data from user folders and other protected places.

Restoring files from the cloud isn't usually an issue, but if you need to restore a file you've deleted, then taking OneDrive as an example, log into your account through your browser. Click the main menu button and select 'Recycle bin' under your PC's entry.

Recovering data from OwnCloud is simple, too — when you reinstall the software and log in as your own user, you're prompted to choose which folder on your hard drive to store your OneDrive content on — once done, the folder syncs up with what's online, restoring any missing data, or you can log on through your browser to download individual files. ■

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- Only 1.4kg

The laptop that can't be replaced by a tablet

apc HOT PRODUCT

WINNER TECHlife READ'S CHOICE AWARD

venomcomputers.com.au

Available from mln.com.au/venom/blackbook

Encrypt important data for free

Make password-protected data silos on your hard disk and USB drives to keep your important and sensitive files safe from prying eyes.

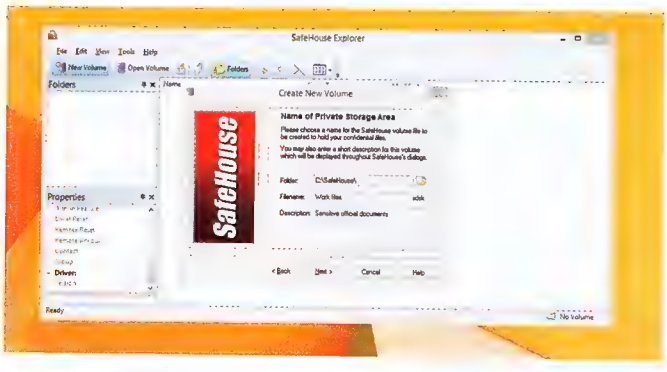
SafeHouse Explorer is a bit of freely available software with which you can create encrypted storage areas known as volumes. Any files you place inside these encrypted storage vaults are automatically encrypted using the industry standard 256-bit Twofish encryption scheme. You can create as many volumes as you need. When you open the encrypted volumes in SafeHouse Explorer, they appear as drives in Windows Explorer. You can then drag and drop any files inside these virtual drives or even save files directly inside them since they'll appear as regular drives within any Windows application. Also, since the entire program resides in a single exe file, it can be moved into a portable drive along with the encrypted data. This allows you to run the program directly from the USB disk and decrypt your data on any Windows computer.

Step-by-step

Password protect your files.

1 DOWNLOAD AND INSTALL

Get SafeHouse Explorer from **www.safehousesoftware.com/SafeHouseExplorer.aspx** for free. Double-click on the 'downloaded .exe' file to launch the setup wizard. During setup, the app will install a special Windows to improve performance. When you launch the app for the first time, it'll guide you through a welcome wizard to help you create your first vault.



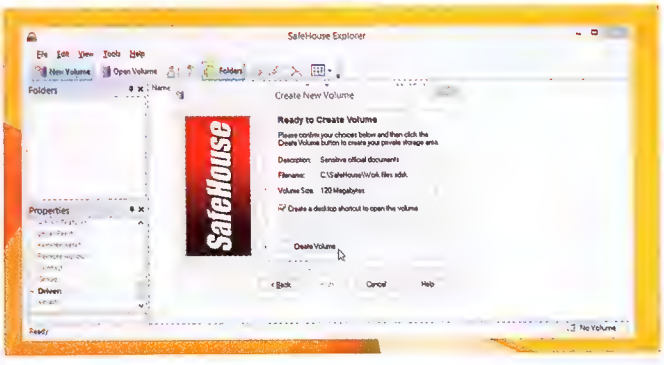
2 DEFINE A VOLUME

To create an encrypted volume, click on the 'New Volume' button. This will launch a wizard that'll guide you through creating the volume. In the first step, you'll be asked to select the location of the encrypted volume. Use the file explorer button to navigate to the drive and folder you wish to store the volume under. Give a name and a brief description of the storage area.

"Any files you place inside these encrypted storage vaults are automatically encrypted using the industry standard 256-bit Twofish encryption scheme."

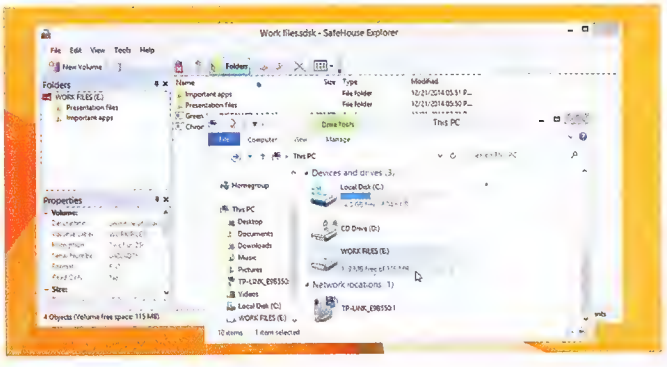
3 SPECIFY ITS SIZE

Next, you need to specify the size of this private storage area. Enter the size of your volume in the 'Volume Size' field. This size can be either in megabytes, kilobytes or even gigabytes, but make sure it doesn't exceed the size mentioned in the 'Space Available' field at the bottom. Go with the default settings for the other options.



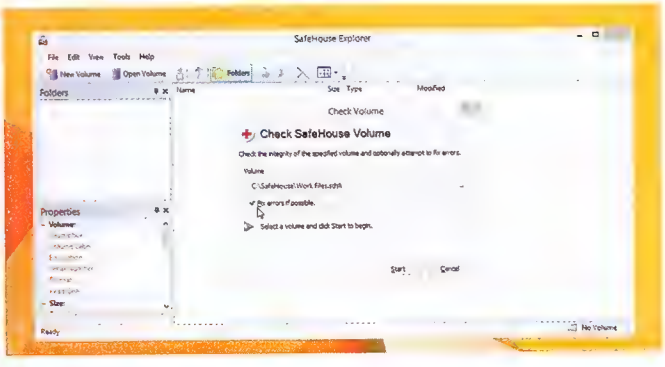
4 CREATE VOLUME

Round up the procedure by entering a password. The program will ask you for this password every time you need to unlock the volume to access your files. If you forget this password, there's no way you can recover it and the encrypted files will be lost forever. When you are done, review the settings and click on the 'Create Volume' button.



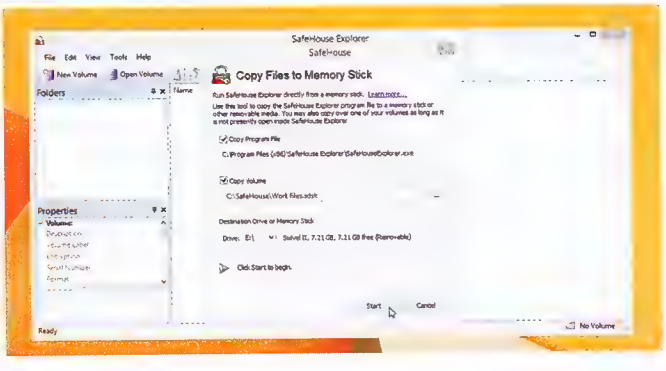
5 INTERACT WITH THE VOLUME

Once the volume has been created, you can use the 'Open Volume' button in the main interface to open it. The program will prompt you for the password you specified earlier to open the volume. Once open, you can drag and drop files into it and it also appears in Windows Explorer. Click on the 'Close Volume' button to lock the storage area.



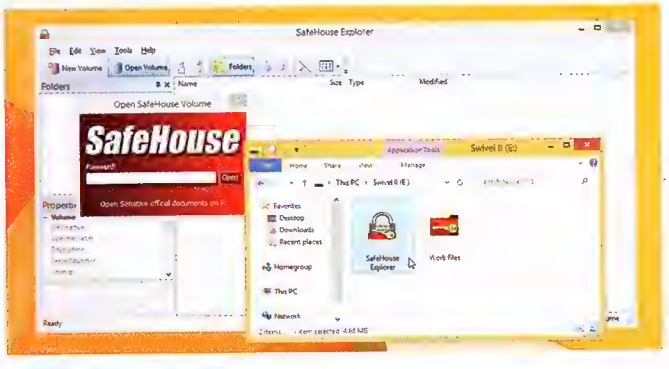
6 VOLUME MAINTENANCE

An important aspect of keeping data inside encrypted volumes is to regularly check their integrity. SafeHouse Explorer includes a tool to do just that. Make sure the volume you wish to check isn't open. Then go to 'Tools > Check Volume' to launch the integrity check wizard and point to the volume's .sdsk file. You can also select 'Fix error if possible' to repair any damages.



7 ENCRYPTED USB DRIVES

SafeHouse Explorer lets you take the encrypted volumes on removable USB drives along with the program itself. Plug in a USB drive and head to 'Tools > Copy Files to Memory Stick'. In the window that opens, select 'Copy Volume' and point to the volume you wish to copy to the USB drive. Make sure 'Copy Program File' is selected and the program is pointing to the correct USB drive.



8 READ ENCRYPTED FILES

Once the program has copied your encrypted volume to the USB disk, it'll include the volume as well as the program's .exe file. Plug in the drive on any other Windows PC and double-click on the .exe file. Follow Step 5 to open the encrypted volume on the USB disk. You can now move your files inside an encrypted volume, carry them and access them on any Windows PC.

Maintain your Mac's storage

Howard Oakley helps you keep a drive in fine fettle throughout its life.

Storage just stores, but to keep retrieval reliable, it needs to be cared for. Over the long term, files progressively get messier and require periodic tidying. While managing what's stored is an important first step in maintaining storage, that isn't our focus here. Instead, we'll concentrate on managing how your files are stored and maintaining the storage medium itself, whether it's a hard disk, solid-state drive (SSD), or a combination. You can, of course, keep most of your files and their backups in remote cloud storage, but the cost of leaving others to do your maintenance is high, and you're reliant on its availability.

Our overriding concerns are performance and reliability. Left untended, hard disks can become progressively slower to access, and impact on a Mac's performance in use. This is becoming increasingly controversial: at one time, many users believed that if they did not defragment (defrag) the files on their drives every month or so, everything would grind to a halt. Improvements in disk systems and the changing demands of OS X now make this a questionable practice, provided that sufficient free space is kept to allow the ready creation and use of cache and other temporary files.

OS X also performs its own background defragmentation when possible, and old ways of forcing it to happen have become more difficult. If you try to clone your startup disk to an external drive and back again – formerly an effective way to consolidate free space – the result may not start up at all. Only if your startup volume is a hard disk, and you're certain its performance has fallen due to fragmentation on it, should you consider trying to defragment it yourself.

DEAL WITH DIFFERENT MEDIUMS

Ultimately, all storage systems develop sporadic errors and may fail catastrophically. Planning for those events is the basis for keeping backups and determines the storage medium used for them. If you could happily see all your stored documents and files blown away at an instant, you do not need a backup, but most of us need good and extensive fallbacks, for which Time Machine running to an external drive is usually ideal.

As far as maintenance is concerned, there are now four main types of local storage: hard disks; SSDs; Fusion Drives, which incorporate both a hard disk and an SSD working together in a Core Storage Logical Volume Group; and network-attached storage (NAS).

A hard disk spins platters coated with magnetic materials inside a sealed enclosure, and is consequently liable to mechanical and electrical failure, and to data corruption. It undergoes maximum stress when being spun up from rest, so tends to last longer when left spinning constantly. It is also sensitive to high temperatures, and a disk running hot is more likely to fail.

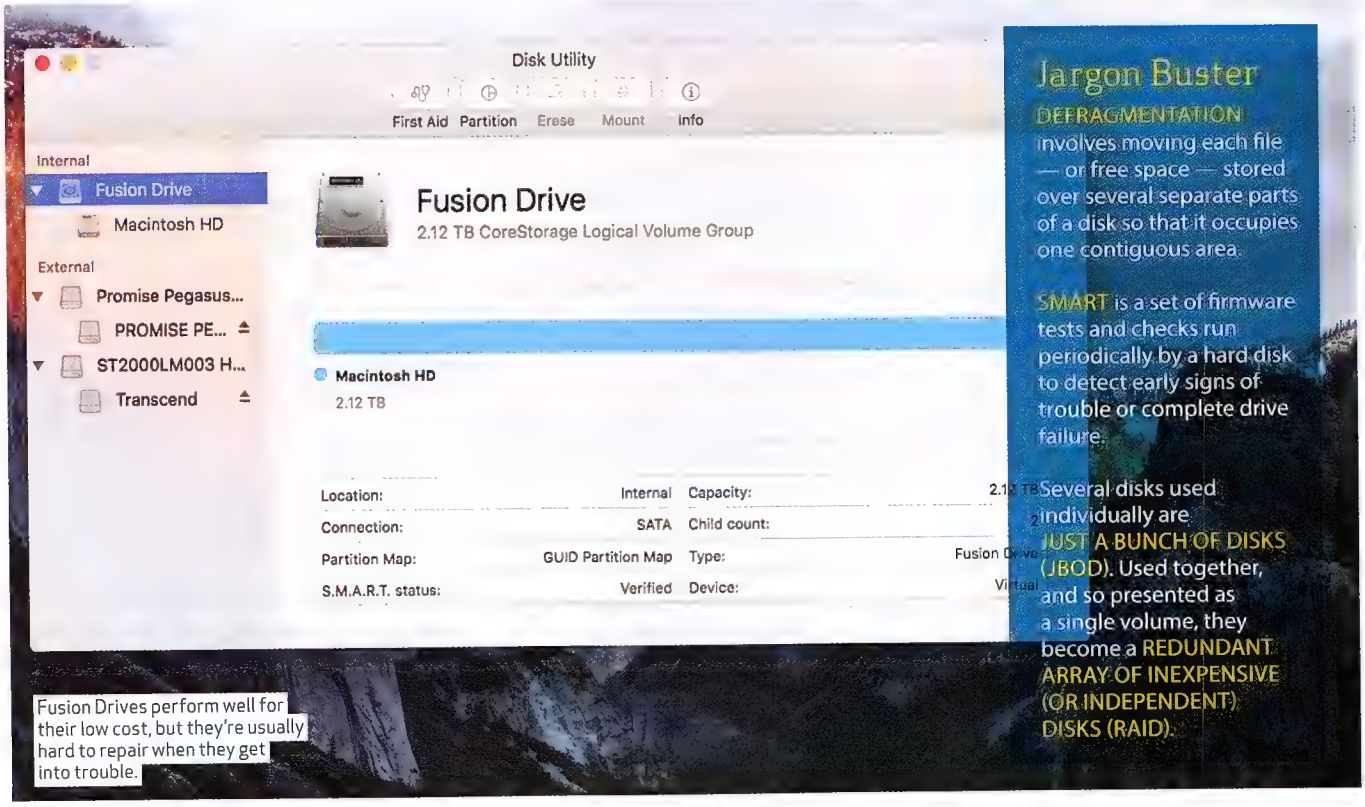
Though more usually used as single units, multiple hard disks can also be installed in larger enclosures to be used individually (JBOD) or in concert as a

veDx Actions Help
Sun 17:23
DriveDx
DIAGNOSTICS
Macintosh HD
Health Indicators 22
Errors Log
Self-tests
Transcend
Health Indicators
Errors Log
Self-tests
Any Type Pre-fail Life-Span Any Status OK WARNING FAILING FAILED
ID name raw value value status
Power On Hours
Power
#9 Power On Hours
Total time the drive is powered on.
The raw value of this attribute shows total count of hours in power-on state. The length of time, in hours, that electrical power is applied to a device.
A decrease of this attribute value to the critical level (threshold) indicates a decrease of the MTBF (Mean Time Between Failures).
When the system or SSD is in Hibernation Mode, the Power-On Hours value does not increment.
Samsung's SSDs support the DIPM (Device Initiated Power Management) feature. Thus, with this feature enabled, this attribute excludes any time the device spends in a "sleep" state. With DIPM off, the recorded value will include all three device power states: active, idle, and sleep.
Program
Erase Fail
Program
Uncorrec
Learn more about health indicators...
Unsafe Shutdown Count
194 Temperature (Celsius)
Hardware ECC Recovered
198 Offline Uncorrectable Sector Count
199 UDMA CRC Error Count
Last checked: Today 17:22:00
DriveDx gives health and performance ratings for your drives, an SSD lifetime indicator, and can email you about problems.

RAID array. RAID used to be a specialist pursuit, but is increasingly common. It is not an instant solution, as there are different levels with performance and robustness trade-offs. Many people find RAID 5 across four hard disks is an ideal compromise, as it allows one of the disks to fail without any loss of data. Simple mirroring, RAID 1, provides redundancy but may impair performance, especially when implemented in software. Hardware RAID implementations are more robust and faster than software RAID, but also more costly.

Hard disks usually fail once their warranty period has expired, commonly after four or more years. Those from the same batch tend to fail around the same time, so it's worth sourcing from different batches when building an array, or two could fail in a short period. Hard disks older than about five years can last longer, but are worth replacing before failure.

SMART monitoring (Self-Monitoring, Analysis, and Reporting Technology) aims to detect early warning signs of failure, and you should always take steps to replace a hard disk with a worrying status before complete failure occurs. However, OS X only



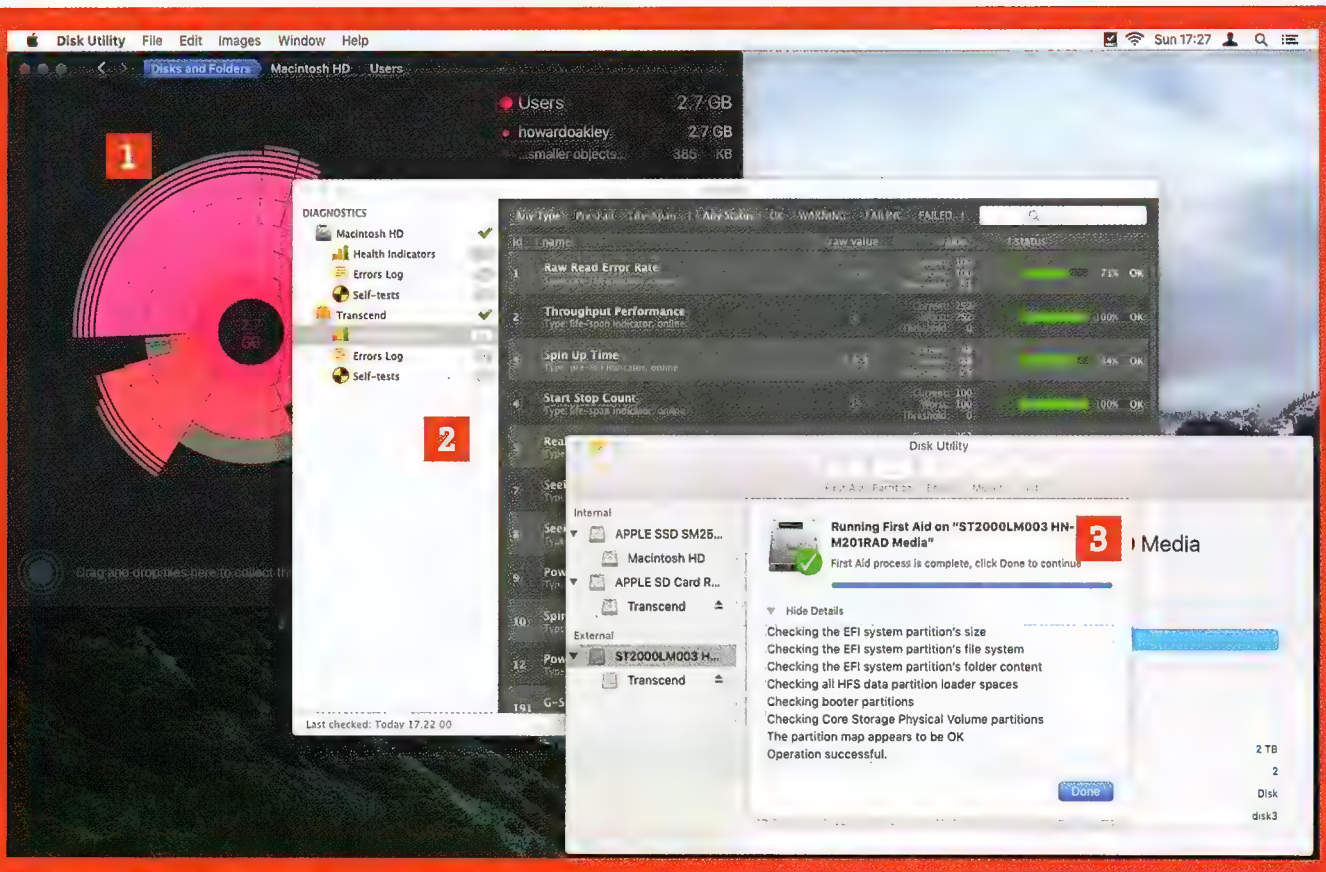
Fusion Drives perform well for their low cost, but they're usually hard to repair when they get into trouble.

Jargon Buster

DEFRAGMENTATION involves moving each file — or free space — stored over several separate parts of a disk so that it occupies one contiguous area.

SMART is a set of firmware tests and checks run periodically by a hard disk to detect early signs of trouble or complete drive failure.

Several disks used individually are **JUST A BUNCH OF DISKS (JBOD)**. Used together, and so presented as a single volume, they become a **REDUNDANT ARRAY OF INEXPENSIVE (OR INDEPENDENT) DISKS (RAID)**.



Explained... The tools you'll use

1 HOUSEKEEPING
It's better to tidy your drives manually, helped by DaisyDisk, rather than use a cleaning tool to abrasively clear out files.

2 SMART STATUS
DriveDx is the best of the SMART status utilities, providing much more detailed information than Disk Utility.

3 DRIVE CHECK AND REPAIR
Disk Utility is generally thorough and reliable, and works with Fusion Drives and other types. Apps like Drive Genius have more extensive checking and repair features than Disk Utility.

supports status monitoring for internal and Thunderbolt drives; USB or FireWire drives can only be monitored by installing third-party extensions.

Disk Utility provides only basic monitoring, and more thorough checking requires a third-party tool such as DriveDx (from US$19.99, **binaryfruit.com**). Good status is no guarantee a disk won't fail in the next instant, just a statement that the chances are very low.

MODERN STORAGE TYPES

SSDs have no moving parts, but their memory chips can be written to a set number of times before they start to fail. In practice, that limit is beyond the life of most people's Macs. However, it's wise to avoid actions that write more to an SSD than is strictly needed, and defragmenting one is pointless and wasteful.

Ensure the TRIM feature is active; it allows the blocks used by deleted data to be reset to a fresh state, and improves performance. It's enabled for Apple's flash storage by default; for other SSDs, the maker should disclose whether it's handled in hardware; if not, the command `sudo trimforce enable` (in OS X 10.10.4 or higher) enables OS X's software implementation for third-party flash storage.

Fusion Drives, fitted by Apple in iMacs and Mac minis, or even made yourself, need care for the hard disk component, but OS X should keep them working efficiently. Many third-party apps do not yet work fully with them, so disaster recovery can be tricky.

Networked storage normally uses one or more hard disks but must be managed through its own software, which often has very limited maintenance facilities. Apple's Time Capsules are managed using AirPort Utility, which lacks manual check and repair commands. So you can do little to care for them, and failure is usually fatal.

END OF LIFE

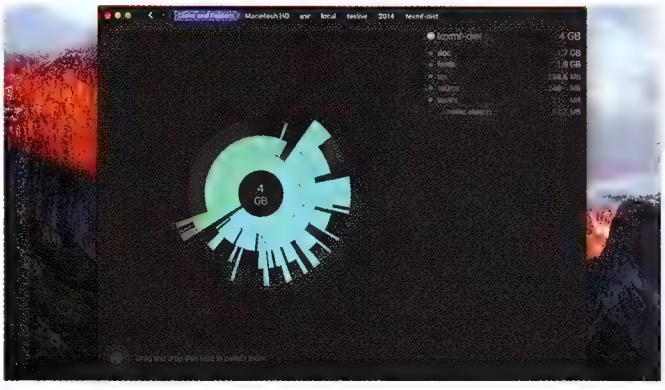
Storage has a life cycle which must be planned for from the outset. Careful choice rather than impulse buying will meet your needs better. Now that OS X supports huge volume sizes, there are few benefits to partitioning large drives into several smaller volumes, although Time Machine backups are best given their own volume to guarantee their size and life.

When drives fail or are replaced, ensure no one else can recover data from them: use Disk Utility to erase and overwrite them, mulitply if you can spare the time. It's generally thought that the more cycles you can manage, the less likely it is anyone will be able to recover data.

Finally, use a sledgehammer to render a drive physically unusable before disposing of it.

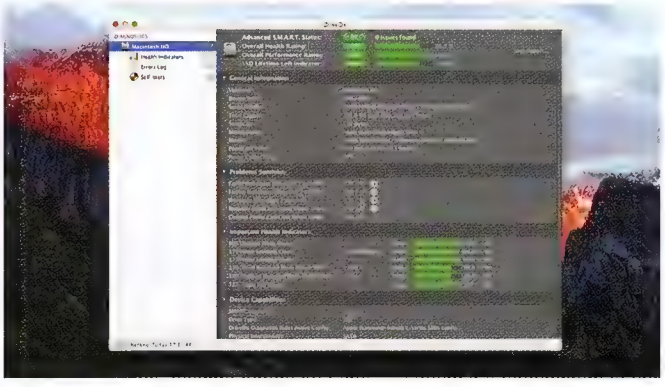
How to

Spring-clean your Mac's storage.



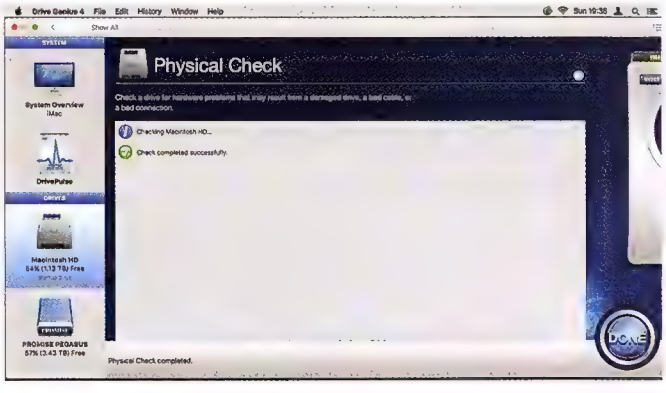
1 DO THE HOUSEKEEPING

Before tackling anything else, use a tool like DaisyDisk in conjunction with using Finder to browse the folders where you normally store work, to clear out temporary files and folders, duplicates, and any other large files that you no longer need.



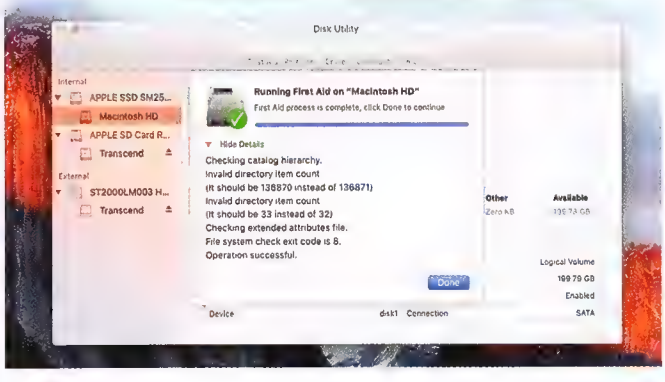
2 CHECK SMART STATUS

Inspect the SMART status and other drive health indicators of each of your drives using a specialist tool such as DriveDx. This app also supports monitoring the status of USB and FireWire drives — which Disk Utility doesn't — if you install the extension provided for that.



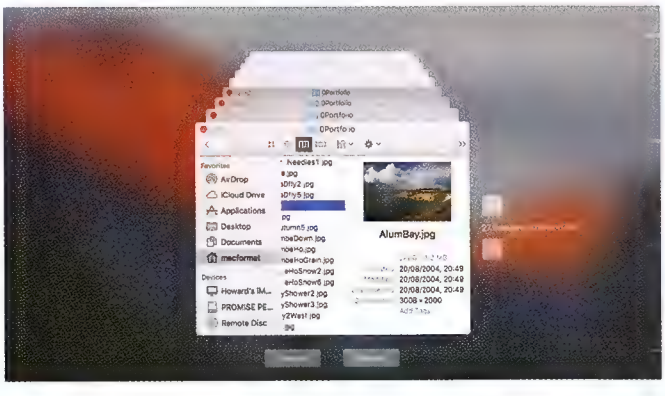
3 RUN A SURFACE SCAN

If you notice that a hard drive is accumulating errors or bad blocks, consider performing a physical check of the medium, including a surface scan. You'll need a third-party utility such as Drive Genius (US$99, **prosofteng.com**) to do this, and scans take hours.



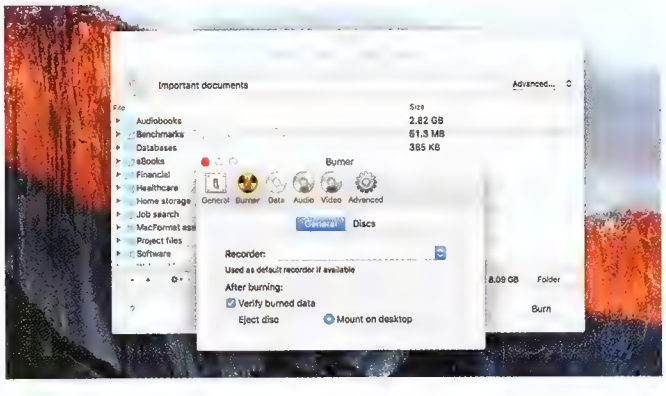
4 MAKE ANY NECESSARY REPAIRS

Run Disk Utility's First Aid command on each drive to check and repair it. This is usually better with the drive unmounted first, so you're best checking your startup disk by restarting your Mac in its Recovery system (hold Command-R at the startup sound), if it needs repair.



5 TEST BACKUP RETRIEVAL

There's no point making backups if they don't work, leaving you unable to access files in them. Open Time Machine, or your preferred backup utility, and verify that you can browse your backups and recover a couple of files from them. Some tools can verify their backups.



6 ARCHIVE IMPORTANT FILES

Finally, archive important documents onto removable storage media. For optical discs, you can use Finder's Burn command or the likes of Toast Burn ($30.99, Mac App Store) or Burn (free, **bit.ly/burnmacapp**). Keep one set of all essential work off-site in case disaster strikes.

4-bay NAS boxes compared

In a world of free (or very cheap) online storage, what can a NAS do for you? Lindsay Handmer compares the best

A key advantage is having access to files and media on a home network, without the restrictions of an internet connections bandwidth or data limits. But modern NAS are also miniature computers in themselves and can run loads of third-party apps to increase functionality. They also make excellent media servers (and, in some cases, with HDMI outputs, players as well), and more powerful units are able to transcode files on the fly, to ensure they can be played back efficiently on any device.

While the hardware side of a NAS is very important, the software is also critical. With that in mind, we tested both the NAS boxes themselves, as well as the operating systems, to give a more complete idea of what they do best. Some NAS are more focused on basic home use, while others have higher-end features or tend to business-centric applications. Smartphone apps also make up a large proportion of functionality, and having easy-to-use and well-supported apps is very important.

Basic NAS CPU and RAM specs are less important in terms of file transfer speeds, and generally determine how well a NAS can handle multiple video streams at once, or its ability to run other apps in the background without slowing down. For large transfers, network bandwidth is the limiting factor in speed, though there are small variations. USB ports can be used for expanding storage, backing up files or connecting other devices, such as printers.

While many NAS are sold diskless, there are also various already-populated boxes that make setup for new users super simple.

HOW WE TESTED

NAS boxes were populated with dual Seagate ENAS 6TB HDDs, running in RAID 0. NAS OS interfaces were tested using Windows 10 and Chrome. Smartphone apps were tested on a Huawei P9 and iPad Mini. Network testing was in single Gigabit mode using a Netgear AC1900 router and CrystalDiskMark, as most home networks don't support link aggregation.

Live demo, 200+ NAS apps, smartphone apps

$ N/A | WWW.ASUSTOR.COM

Asustor Data Master 2.6

Freshly updated in April 2016.

ADM 2.6 has loads of new features and file structure updates, though it's worth noting that, if updated, the changes mean the NAS can't be rolled back to an older version. ADM 2.6 has improved third-party app compatibility, can handle more MyArchive disks, supports more file systems, has better security and features a wider range of streaming and social media apps.

For those who like to try before they buy, Asustor has a live demo website for ADM 2.6 (at **www.asustor.com/live_demo**).

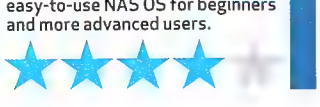
While some models have HDMI outputs, the NAS OS is mostly accessed via web browser. The layout is very clean, with a simple flat (tabbed) graphical interface (with moveable icons) that can display multiple windows at once. The interface allows NAS management, app use, as well as remote file access. There is also a search function to help find functionality or settings.

Asustor provides a huge range (over 200) of apps (from VPNs to video security) in App Central, which can all be installed with one click and run on a compatible NAS. Of course, AMD 2.6 can manage all your media needs, including running Plex, transcoding and streaming to other devices. AMD 2.6 is also dedicated to ensuring your computers are always backed up, and works with Apple's Time Machine, and has its own Windows software.

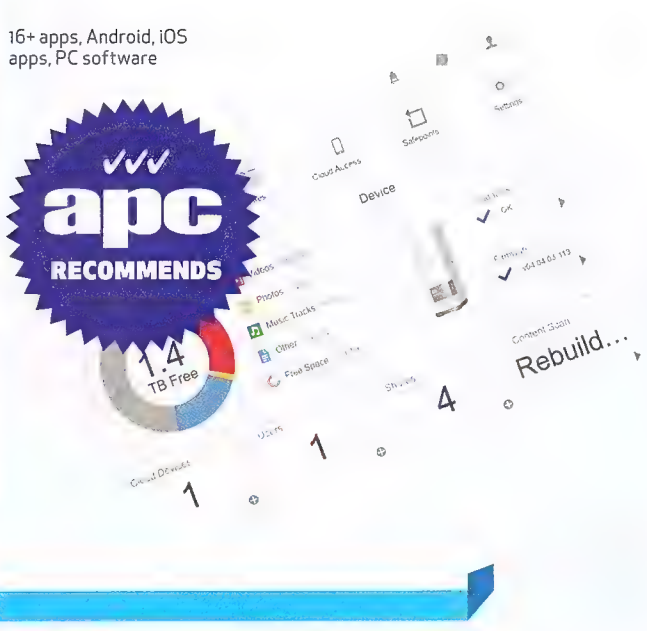
Asustor also has a very effective range of smartphone apps to handle tasks such as streaming, NAS management, IP camera security and more.

Verdict

A very comprehensive and easy-to-use NAS OS for beginners and more advanced users.



16+ apps, Android, iOS apps, PC software



$ N/A | WWW.WDC.COM

WD My Cloud OS 3

The latest shiny interface from Western Digital.

Launched late 2015, My Cloud OS 3 gives WD NAS a total makeover, and has released incremental updates since. The OS is focused on making day-to-day tasks (such as remote access and auto backups) super simple, while still retaining higher-end functionality for more advanced users.

The browser interface has a very well optimised layout, tabbed but not customisable. Handily, many tabs (such as Shares) include a short bit of information about what they do, and links to further help topics. While many WD NAS come with drives, the OS also walks you through the process of getting set up or changing the RAID configuration.

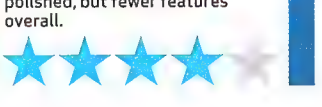
My Cloud OS 3 is built around being able to access your files and media anywhere, on any device, and keep it all backed up automatically. But it can also run a small number of third-party apps, such as Plex, sync with existing Cloud storage or stream to DLNA-compatible devices. That said, the range is very limited compared to some other NAS.

Instead, where the WD My Cloud NAS and OS shine is with integration with your other devices. The My Cloud mobile app (Android and iOS) is very polished, and makes it a breeze to access files and media remotely, or back up photos from a smartphone. There is also software available for PC and Mac, such as for handling backups and automatic syncing.

In many ways (such as NAS apps), My Cloud OS is lacking key features, but by focusing on the core usability, WD has created one of the easiest to use NAS ecosystems out there.

Verdict

Extremely easy to use and polished, but fewer features overall.



Live demo, customisable interface, 189+ NAS apps, Android and iOS apps

$ N/A | WWW.QNAP.COM

QNAP QTS 4.2

Upgraded in late 2015.

Compared to the older 4.1 version, the new QNAP QTS 4.2 operating system brings a host of new and upgraded features. To help make using a QNAP NAS easier, the user interface has been given a total makeover, with an intuitive flat design that is easier to navigate. After drive installation, the OS does a decent job of guiding the (rapid) process and has a handy quick start guide.

To help users get a handle on the OS, QNAP actually has a live demo website (**demo.qnap.com**). Logging in mimics connecting to a NAS at home via the internet and allows you to delve into the available settings and apps.

The QNAP web interface is a mixture of smartphone-style home screen and specific icons (such as Music and Photo stations) that can be repositioned by dragging. It uses bright colours which stand out, but give a feel reminiscent of '90s websites, rather than the latest industrial design. That is totally fine, though, because the interface is a pleasing mix of comprehensive control and features, and beginner usability.

The QNAP OS can also run third-party apps, and has a huge (189+) range, from Gmail backups to media players, download utilities and DIY hosting.

For smartphone use, QNAP has a range of apps available for Android, iOS and Windows mobile – though not all are available on every platform. Somewhat frustratingly, QNAP split functionality (such as file, music video and photo viewing) into separate apps, rather than doing it all with one. Still, the actual apps themselves are very good, and frequently updated.

Verdict

An excellent feature set that caters to high-end users while still being approachable for beginners.

Live demo, 75+ NAS apps, Android, iOS apps

$ N/A | WWW.NETGEAR.COM.AU

Netgear ReadyNAS OS 6

Get the most from your Netgear NAS.

ReadyNAS OS 6 was launched back in 2013, but has had continual updates and is now up to v6.5.1. We had an older Netgear NAS on hand to test the process with, which can be done either directly through the NAS if connected to the internet or from a local drive. The process is very quick and easy, and after a reboot, the NAS was ready to go with the latest version. For those who want to try it out, Netgear has a ReadyNAS OS 6.5 demo available online at rndemo.netgear.com.

Access via a web browser, the ReadyNAS interface looks a little complex at first, but is actually quite straightforward, though not customisable. The default view shows system info, with a number of tabs to access other pages, such as managing shared drives and folders. When buying a diskless NAS, dropping in some drives and getting up and running with your preferred RAID configuration is also nice and easy.

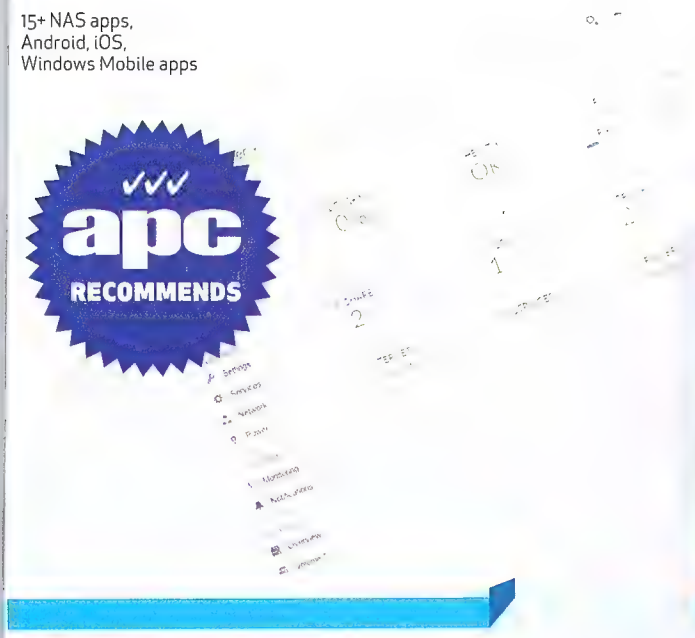
ReadyNAS OS6 can run third-party apps, and while the selection isn't as large as some, there are still 75+ options available. You can also use it to create a personal cloud, sync to existing cloud storage, and handle automated backups for computers on your network.

The free Netgear ReadyCLOUD smartphone app is fairly well put together and up to date and gives remote access to files, and can automatically backup photos. There is also a separate app for monitoring and controlling your network and NAS, and another for IP Cameras, but these were a little more finicky in testing.

Verdict

While not as slick as the competition, ReadyNAS OS 6 is comprehensive and easy to use.

15+ NAS apps, Android, iOS, Windows Mobile apps



$ N/A | WWW.SEAGATE.COM

Seagate NAS OS 4

Now updated to version 4.2.

Based around a web interface, Seagate's NAS OS 4 tends towards a simplified, uncluttered layout, which is aimed at professional users. Of course, Seagate NAS are also popular for home use (such as the lounge-room-ready Personal Cloud products) so the Seagate boffins have worked to make it an intuitive as possible.

Most Seagate NAS come equipped with drives, so setup is as simple as logging into the web interface and choosing a few settings, such as RAID type. The OS supports DLNA media streaming, which makes it fast and easy to view stored content on other devices. Rather than a tabbed or adjustable style layout, NAS OS 4 has a fixed menu on the left, for selecting different settings and setup options.

For extra functionality, NAS OS 4 has 15 apps available that can run directly on the device, such as a network video recorder, Plex Media Server, IFTTT integration and more. While not as comprehensive a list as some of the competition, it's enough core usability for most users. To help out those on PC and Mac, the Seagate Sdrive software sets up a direct link (that works remotely) straight to your files. This is very handy, as it takes any guesswork out of getting connected. The NAS also has options to simplify RAID setups, NAS-to-NAS backups and power management.

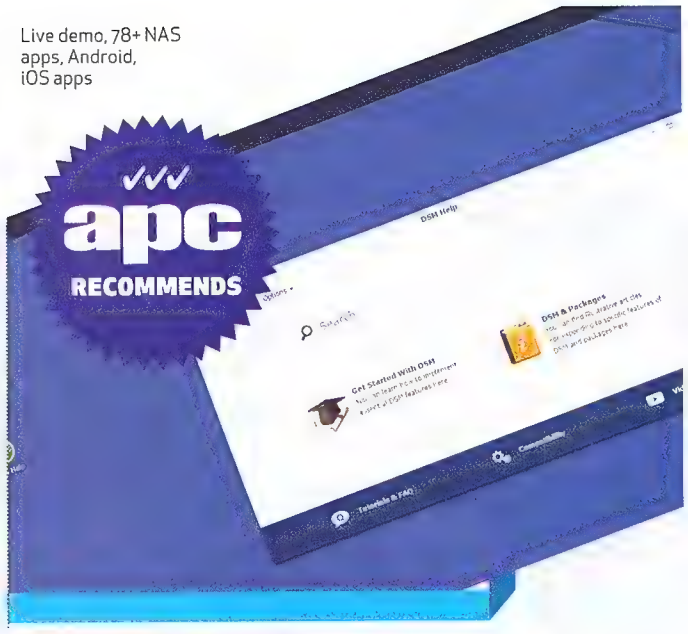
Linking into the NAS OS is done via one core app (Seagate Media), on Android, iOS, and Windows, plus another for backups. The apps are very well put together, with a slick easy-to-use interface and frequent updates.

Verdict

A slick and easy-to-use NAS OS that handles backups and media streaming with ease.

★★★★☆

Live demo, 78+ NAS apps, Android, iOS apps



$ N/A | WWW.SYNOLOGY.COM

Synology Disk Station Manager 6

Has Synology built the most customisable NAS OS?

After around six months of beta testing, Synology has released its DSM 6.0 operating system. Some key new features include the ability to run multiple virtual machines in one NAS, better security and loads of new business-focused features.

The DSM 6.0 web interface is reminiscent of a computer desktop, with customisable icons and theme, system health and resource monitoring widgets and even a 'start button' up top. To make it simpler for first-time users, the OS opens up a help window by default, with links tutorials and other information, plus search. It also walks new users through the process of getting a newly populated NAS up and running with minimal fuss.

DSM 6.0 can also run NAS apps, and has a one-click install Package Centre with 78 (at the time of writing) programs available, from an antivirus to WordPress hosting. The OS also has all sorts of other productivity tools, such as Google Docs style collaboration tools and a secure email service.

Like many other manufacturers, Synology has a live demo of DSM 6.0 that can be checked out online at **www.synology.com/en-global/dsm/live_demo**.

Synology has one of the largest ranges of phone apps available, for both Android and iOS. There are the usual management, streaming, backup, IP camera and personal cloud apps – all of which are extremely well put together and frequently updated.

But Synology also has some other productivity-focused apps, such as a collaborative note taking and to-do list app, as well email management.

Verdict

DSM has top-notch features and apps for high-end and business users.

★★★★☆

4-BAY NAS REVIEWS

CPU: Intel Celeron CPU; **RAM:** 2GB DDR3; HDMI 1.4b output; dual Gigabit Ethernet; 3x USB 3.0; hardware transcoding; optional remote

$679 | WWW.ASUSTOR.COM

Asustor AS6104T

Aimed at multimedia entertainment lovers.

Thanks to powerful CPUs and excellent apps (not to mention HDMI outputs and a remote control), a network attached storage device can make for an effective media player replacement.

In the case of the AS6104T, the NAS has a HDMI 1.4b port which can output up to 4K video directly to a TV, plus S/PDIF. It also supports Kodi (and other apps) and control is either via an (optional) IR remote control, or through a smartphone app. The four-bay AS6104T uses a powerful Intel Celeron Dual Core CPU (which can burst to 2.48GHz), as well as 2GB of expandable dual channel DDR3L RAM. The NAS can handle up to four 8TB HDDs (2.5-inch or 3.5-inch), for a total of 32GB, and configure them in RAID.

The AS6104T has hardware transcoding, which makes it easy (and quick) to convert video files to formats, resolutions and bitrates to suit playback on different devices and connections. The NAS has dual Gigabit Ethernet connections round the back, plus three USB 3.0 ports – one of which is on the front. You also get dual eSATA and two extra USB 2.0 connections. The NAS has a system fan, but it's very quiet in real-world use. It also supports hardware-based AES-NI encryption.

The AS6104T is tool-less, which makes installing drives very quick and easy. There is also a large range of apps available to create a personal cloud, or run applications directly on the NAS itself.

Verdict

A well-featured NAS ideal for handling media.

★★★★☆

CPU: Intel Celeron N3150 CPU; **RAM:** 4GB / 8GB; 4x M.2 SATA III; dual Gigabit Ethernet; dual HDMI; 4x USB 3.0; 1x USB 2.0

$700 (4GB) | WWW.QNAP.COM

QNAP TBS-453A NASbook

A portable media NAS with a twist.

For most use, a NAS is best suited to very affordable but also reliable HDDs. While many NAS support 2.5-inch drives, SSDs are not as cost effective for NAS use. The QNAP TBS-453A changes all that with a super compact miniature NAS that has four M.2 SATA SSD bays (with temperature monitoring). In fact, it can't take normal drives at all, and measures in at just 20mm x 230mm x 165mm and weighs 760 grams.

The TBS-453A has dual HDMI outputs on the rear, which can output 4K video. It also has a built-in speaker, a line-out jack and dual 3.5mm MIC inputs. It also has a five-port gigabit switch built in – two of which can be teamed together for faster transfer rates. It also has four USB 3.0 ports, plus a 2.0 connection, which support flash drives and other options such as printers.

The tiny NAS is powered by an Intel Celeron N3150 quad-core CPU, which can burst up to 2.08GHz, backed up by either 4GB or 8GB of RAM. The NAS is available diskless, as well as with M.2 SSDs pre-installed.

We tested with dual 250GB Samsung 850 EVO M.2 SSDs and sequential performance is on par with other NAS (Ethernet limited) but random access is significantly improved.

The NASbook has loads of software features, and can be run as a mini-PC with dual monitors, and even has an app to turn it into a portable karaoke machine.

Verdict

A fantastically unique little NAS that has a lot to offer despite the high price tag.

★★★★☆

CPU: Intel Celeron N3060; **RAM:** 1GB DDR3; dual Gigabit Ethernet; 3x USB 3.0 ports; hardware transcoding

$650 | WWW.SYNOLOGY.COM

Synology DS416play

The latest media NAS from the Synology engineers.

Aimed at home and creative professional users, the DS416play mixes high-end media-focused features with a power-efficient architecture. The Synology NAS uses the new (Q1, 2016) Intel Celeron N3060 CPU, which uses a 14nm process, has a 6W TDP and can burst to frequencies of 2.48GHz. It also has 1GB of DDR3 RAM, and can handle both 3.5-inch and 2.5-inch HDDs.

Over the four hot swappable bays, it supports RAID and both Btrfs and EXT4 file systems. The NAS has built-in hardware encryption, as well as transcoding of common codecs (including H.265) at up to 4K resolutions. Round the back, the unit has dual Gigabit LAN ports, which can be used in link aggregation mode for extra performance, or failover to improve redundancy. The NAS also has three USB 3.0 ports – one of which is on the front.

The DS416play is extremely easy to populate with HDDs and get up and running, with an intuitive interface and tutorials. It also has loads of NAS apps available for extra functionality, plus an extensive array of slick, easy-to-use iOS and Android smartphone apps.

Performance is quite good, though for large file transfers, limited by the Ethernet throughput. Thanks in part to the efficient CPU, the NAS is very quiet in use, with slow spinning fans.

In an ideal world, the DS416play is a feature-packed, yet more affordable NAS than its brethren, but for now, it is still fairly new and faces stiff competition on price.

Verdict

A great all-round NAS for home and media use, but still a touch expensive.

★★★½☆

CPU: Intel Pentium N3710; **RAM:** 2GB, 8GB; dual Gigabit Ethernet; 3x USB 3.0 ports; eSATA

$669 | WWW.SYNOLOGY.COM

Synology DS916+

With powerful media centric capabilities.

Aimed at high-end home users, or those who need professional-level features, the Synology DS916+ has a lot on offer. The four-bay NAS uses the very new (Q1, 2016) quad-core Intel Pentium N3710 CPU, which can burst from 1.6GHz up to 2.56GHz. The DS916+ is available with either 2GB or 8GB of RAM, though the latter has a ~$90 price premium. It can handle both 2.5-inch and 3.5-inch drives, up to 32TB total. The NAS supports both hardware encryption (AES-NI) and hardware transcoding up to 4K resolutions and 30 frames per second. It can also use drives formatted EXT4 and Btrfs, and run them in RAID 0, 1, 5, 6, 10, JBOD and Synology's own Hybrid RAID.

Round the back, the DS916+ sports dual Gigabit Ethernet (with link aggregation), 2x USB 3.0 (there is another up front) and eSATA. You can also expand the NAS with an extra five drives, using the DX513 module, for $569.

The unit is tool-less, so dropping in drives is very quick and the NAS then walks you through the (rapid) setup process.

The DS916+ can run apps directly, and has a huge library of options available, starting with media serving, auto backups and IP camera recording. Synology also provides some of the best smartphone apps out there, for remote management and access to media.

Performance is excellent, and the NAS has no trouble extracting top-notch throughput from a Gigabit Ethernet connection.

Verdict

A pricey but performance-oriented NAS with high-end transcoding abilities.

★★★★☆

CPU: ARM Cortex A15; **RAM:** 2GB DDR3; 2x Gigabit LAN; 3x USB 3.0; eSATA

$570 | WWW.NETGEAR.COM.AU

Netgear ReadyNAS 214

An all-rounder NAS with plenty of features.

With the ReadyNAS line refreshed in 2015, the 214 is a higher-end model aimed at media consumers and other pro-level users. Rather than an Intel chip, the 214 features a quad-core ARM Cortex A15 CPU that hums along at 1.4GHz, as well as 2GB of RAM. Aside from running Plex or Kodi (and streaming to your devices), the 214 can transcode 1080p media in real time.

The 214 can accept both 2.5-inch and 3.5-inch drives (hot swappable) and run them in RAID for extra performance or redundancy. It also features dual Gigabit LAN ports, which can run in link aggregation mode for increased throughput. To connect external drives and other devices, the 214 has eSATA as well as three USB 3.0 ports – one of which is on the front.

Performance is quite good and the Netgear NAS has no problems making full use of a Gigabit network. The NAS does not have a model with pre-installed drives, but adding your own is very easy. Likewise, the setup process is fairly straightforward, and we didn't run into any snags during testing. The NAS does a fairly good job at containing HDD noise, and the fan is pretty much inaudible.

Netgear also has a range of software options that can run on the NAS itself, such as IP camera security, torrent downloading, automatic backups and Plex. It's also possible to create a personal cloud or stream media, using the all right but not amazing Netgear smartphone apps.

Verdict

Capable, but it lacks some of the more advanced media-focused features of the closest.

★★★½☆

CPU: Intel Atom C2338; **RAM:** 2GB DDR3; 2x Gigabit Ethernet; 2.5" and 3.5" drives; 2x USB 3.0; 1x USB 2.0

$540 (DISKLESS) | WWW.SEAGATE.COM

Seagate NAS Pro 4 Bay

A step above the base model.

Aimed at power users, the Seagate NAS Pro is available as a two-, four- and six-bay NAS – either diskless or pre equipped with HDDs. The unit features a relatively powerful Intel Atom C2338 dual-core CPU that hums along at 1.7GHz, as well as 2GB of RAM. For faster transfers, it has dual Gigabit LAN ports which can be run in link aggregation mode. It also has dual USB 3.0 ports, as well as a single USB 2.0 connection, for backing up flash drives or expanding the storage.

The four-bay NAS is available in 4TB, 8TB, 16TB and 20TB models, though these are somewhat expensive compared to the diskless model. The bays accept 2.5-inch and 3.5-inch drives, are hot swappable, and can be run in RAID, 0, 1, 5, 6, 10 and JBOD.

Thanks to NAS OS 4, setting up the Seagate NAS is very easy, while it still retains loads of high-end features. The NAS Pro can run software such as Plex, integrate with IFTTT or record video from IP cameras. Seagate also has a range of excellent smartphone apps for personal cloud creation and streaming. Performance is quite good, and the NAS has no trouble giving high transfers rates and streaming video.

For those who want to save some money, the 2 Bay NAS Pro is a good $200 cheaper. While less powerful, the standard NAS 4 Bay is about $150 (diskless) – which is also a decent saving for those who don't need the extra grunt.

Verdict

A decent all-round NAS that does the job but does not stand out from the crowd.

★★★½☆

CPU: Marvell Armada 388; **RAM:** 2GB DDR3; 2x Gigabit Ethernet; 3x USB 3.0; dual power

$615 | WWW.WDC.COM

WD My Cloud EX4100

For those who want a more comprehensive NAS option.

Base model NAS units get the job done, but the slightly more expensive mid-range models have a lot to offer. The WD My Cloud range includes a home-focused NAS, but also has a range of models aimed at prosumers. The EX4100 features a fairly powerful Marvell Armada 388 CPU that runs at 1.6GHz, plus the standard 2GB of DDR3. For increased throughput, the NAS has dual Gigabit LAN ports which can be used in link aggregation. The EX4100 only accepts 3.5-inch HDDs (hot swappable), and supports both RAID as well as AES 256-bit encryption. The NAS is available as both a diskless model, and in 8TB, 16TB and 24TB capacities.

Round the back, the WD NAS has dual power inputs for those who crave redundancy, as well as dual USB 3.0 ports. There is also another USB 3.0 connection up front, plus a small LCD readout that gives fast access to critical information.

The My Cloud OS is one of the best out there, and makes it very fast and simple to get the drive up and running. It also offers fairly strong read and write performance, evening when handling other tasks.

The WD NAS can run a range of software (such as Plex), stream media, and has one of the best range of smartphone apps available.

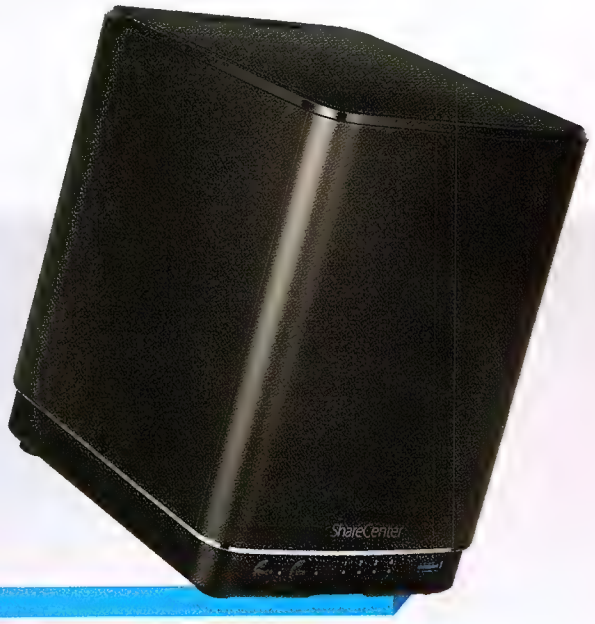
It's worth noting that the two-bay version of the drive (EX2100) actually has lower spec hardware, along with the reduced drive bays.

Verdict

A very capable NAS, albeit with a more limited range of media-centric features.

★★★½☆

CPU: Marvell Armada 370; **RAM:** 512MB DDR3; 2x Gigabit Ethernet; 2x USB 2.0; 1x USB 3.0



$329 | WWW.DLINK.COM.AU

D-Link ShareCenter DNS-340L

Do you need an affordable NAS?

A four-bay NAS has a lot of advantages over a two-bay, but the price jump tends to be a little painful considering the underlying spec is usually the same. The D-Link DNS-340L aims itself at budget users who want a basic NAS for serving up media and handling backups. That is not to say the NAS isn't capable – it even has dual Gigabit Ethernet ports for better throughput.

Inside, the DNS-340L hides a 1.2GHz Marvell Armada 370 CPU with 512MB of RAM. The top loading HDD bays only accept 3.5-inch drives (hot swappable), but can run them in RAID 0, 1, 5, 10 and JBOD.

Round the back, it has dual USB 2.0 ports (that can handle printers), and a single faster 3.0 connection on the front. The NAS can also do volume encryption, but will take a significant hit on performance.

The D-Link NAS is only available as a diskless model, and while the drives are easy to slot in, getting up and running is a slightly longer process than most. On the plus side, the NAS OS is quite good, and the unit can handle other tasks, such as torrents and IP camera recordings. D-Link also has an mdlink Access app, which gives remote access and NAS management from a smartphone.

Performance is a mixed bag, but considering the price, it's not as bad as it looks. Link aggregation mode on the dual LAN could be used to increase throughput, but ultimately the NAS has no problem handling backups and media streaming.

Verdict

A low-cost, basic NAS for those who don't need higher-end features.

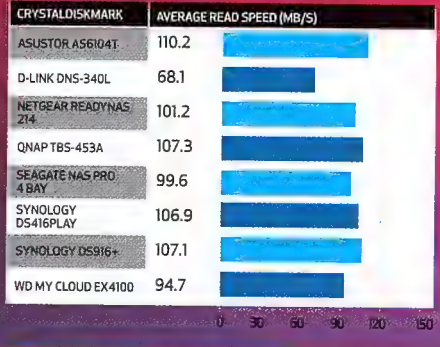
★★★½☆

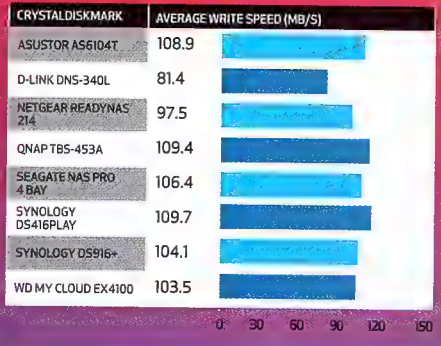
NAS OS

	SCORE	LIVE DEMO	NAS APPS	SMARTPHONES APPS
ASUSTOR ADM 2.6	4	YES	200+	ANDROID, IOS
WD MY CLOUD OS 3	4	NO	16+	ANDROID, IOS
QNAP QTS 4.2	4	YES	189+	ANDROID, IOS
NETGEAR READY-NAS OS 6	3.5	YES	75+	ANDROID, IOS
SEAGATE NAS OS 4	4	NO	15+	IOS, ANDROID, WP
SYNOLOGY DSM 6.0	4	YES	78+	ANDROID, IOS

"Basic NAS CPU and RAM spec are less important in terms of file transfer speeds, an generally determine how well a NAS can handle multiple video streams at once, or its ability to run other apps in the background without slowing down."

LABS BENCHMARK RESULTS





4-BAY NAS BOX SPECIFICATIONS

	SCORE	PRICE	CPU	RAM	DRIVE TYPE	ETHERNET	HDMI	USB	OTHER
ASUSTOR AS6104T	4	$679	INTEL CELERON DUAL CORE	2GB	2.5" AND 3.5"	DUAL GIGABIT	YES	3X USB 3.0	OPTIONAL REMOTE
D-LINK DNS-340L	3.5	$329	MARVELL ARMADA 370	512MB	3.5"	DUAL GIGABIT	NO	2X USB 2.0, 1X USB 3.0	
NETGEAR READYNAS 214	3.5	$570	ARM CORTEX A15	2GB	2.5" AND 3.5"	DUAL GIGABIT	NO	3X USB 3.0	ESATA
QNAP TBS-453A	4	$700	INTEL CELERON N3150	4GB / 8GB	M.2 SATA	DUAL GIGABIT	2X	4X USB 3.0, 1X USB 2.0	SPEAKER, MIC INPUTS, LINE OUT
SEAGATE NAS PRO 4 BAY	3.5	$540	INTEL ATOM C2338	2GB	2.5" AND 3.5"	DUAL GIGABIT	NO	2X USB 3.0, 1X USB 2.0	
SYNOLOGY DS416PLAY	3.5	$650	INTEL CELERON N3060	1GB	2.5" AND 3.5"	DUAL GIGABIT	NO	3X USB 3.0	
SYNOLOGY DS916+	4	$669	INTEL PENTIUM N3710	2GB / 4GB	2.5" AND 3.5"	DUAL GIGABIT	NO	3X USB 3.0	ESATA
WD MY CLOUD EX4100	3.5	$615	MARVELL ARMADA 388	2GB	3.5"	DUAL GIGABIT	NO	3X USB 3.0	DUAL POWER

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Best HDDs for your NAS

Lindsay Handmer tests a swathe of hard drives designed specifically for use in network attached storage devices.

As tempting as it is to use the cheapest HDD possible for bulk storage, there are good reasons to buy a drive designed for NAS use. Importantly, the drives are engineered for the application to give higher reliability and are backed by longer warranties. NAS drives have a lot of extra features and optimisation, and use special firmware designed to give better performance – especially in RAID and large arrays. NAS manufacturers such as Synology report that many of their support issues involve desktop drives used in NAS devices.

For always-on operation, the drives are built to reduce vibration, which can destroy bearings over time, and to better handle vibration from other nearby drives. They also have better error recovery, to help make sure no data is ever lost. NAS builders also test NAS HDDs in their devices, so you can be sure of excellent compatibility.

Of course, NAS drives are more expensive – from around $10 extra per TB for basic models, to $20 for medium-grade enterprise level and more than double the cost for high-end drives.

For home use, the basic NAS models are a big improvement compared to desktop HDDs. For prosumer and critical business use, enterprise drives offer even better reliability and other premium features, such as 24/7 support.

For NAS use, access speeds are not the most critical aspect – though higher-end models are generally a little faster. Reliability is given by MTBF (mean time between failure),

HOW WE TESTED

We benchmarked each drive individually using CrystalDiskMark to give a comparative measure of performance. Smaller capacity drives (not tested) generally have slightly lower performance, so we also included the manufacturer's MB/s rating as a comparison. For NAS use, two drives (where possible) were installed in a QNAP TS-251+ NAS, running in RAID 0 (performance). Testing was done via a gigabit network using a Netgear AC1900 router. It's worth noting that these result don't vary a lot, as the network and NAS is the major bottleneck.

3.5-INCH NAS HARD DRIVES

Capacity: 3, 4, 6TB; **RPM:** 7,200rpm; **Cache:** 64 / 128MB; **Endurance:** Not given; **MTBF:** 1 million hours; **Dollars per TB:** $63–$65; **Warranty:** 3 years

$250 (4TB)
WWW.HGST.COM

HGST Deskstar NAS

Built for high performance data storage.

These drives are aimed to fit in between the entry-level NAS HDDs and the more expensive enterprise options. They're available in 3, 4 and 6TB options, at 7,200rpm.

While performance is quite good, the drives are only a touch cheaper than the best value Seagate Enterprise model (4TB), but with a lower warranty and MTBF rating. At other capacities, the Deskstar drives cost about the same per TB, which does compare favourably to the same capacity in other drives.

The problem is that the drives only go up to 6TB, so have a fairly limited appeal. It's also worth noting that HGST is actually owned by Western Digital, but operate separately.

Verdict

An interesting mix of entry-level and enterprise spec, but the price per TB is not compelling.

★★★½☆

Capacity: 2, 3, 4, 5, 6, 8TB; **RPM:** 7,200rpm; **Cache:** 256, 128MB; **Endurance:** 300TB a year; **MTBF:** 1.2 million hours; **Dollars per TB:** $65–$98; **Warranty:** 5 years

$260 (4TB)
WWW.SEAGATE.COM

Seagate Enterprise NAS

Mid- to high-end NAS and business.

Available in 2, 3, 4, 5, 6 (tested) and 8TB capacities, with a SATA III interface, 3.5-inch form factor and a 7,200rpm. The 8TB drive has 256MB cache, while the other drives make do with 128MB. Endurance (for small business) is 300TB a year and 1.2 million hours MTBF.

The drives are aimed at professional-level users who want a step up from basic NAS drives, with excellent reliability. The drives are about 30% more expensive than their lower-end NAS cousins, but also offer better endurance and a two-year longer warranty. The smaller capacity drives also maintain a 7,200rpm. The sweet spot is 4TB, which is significantly cheaper per TB than any other capacity.

Verdict

Solid endurance and reliability, without a huge price increase over basic NAS drives.

★★★★☆

Capacity: 2, 3, 4, 5, 6, 8, 10TB; **RPM:** 5,900, 7,200rpm; **Cache:** 256, 128, 64MB; **Endurance:** 180TB a year; **MTBF:** 1 million hours; **Dollars per TB:** $51–$75; **Warranty:** 3 years

$205 (4TB)
WWW.SEAGATE.COM

Seagate IronWolf

The latest consumer NAS drives.

The Seagate IronWolf range is aimed at home and small business users, and introduces a new 10TB capacity, along with 2, 3, 4, 6 and 8TB models. At the time of writing, the new Ironwolf drives were slightly more expensive than their NAS brethren, except the 6TB capacity. The 2, 3 and 4TB models run at 5,900rpm, with 64MB of cache, while the 6, 8 and 10TB use 7,200rpm, with 128MB cache (256MB on the 10TB).

The drives are backed by a decent three-year warranty, have a 1 million hour MTBF and handle workloads of 180TB a year. The tested 10TB model offers excellent transfer rates (the lower capacity drives are slower), but are still a step down from the Enterprise NASs.

Verdict

Prices still need to settle, but the new IronWolf series is a compelling consumer NAS option.

★★★★☆

Capacity: 2, 3, 4, 5, 6, 8TB; **RPM:** 5,900, 7,200rpm; **Cache:** 256, 128, 64MB; **Endurance:** 180TB a year; **MTBF:** 1 million hours; **Dollars per TB:** $50–$69; **Warranty:** 3 years

$200 (4TB)
WWW.SEAGATE.COM

Seagate NAS

Is this the most affordable NAS hard drive?

Available in 2, 3, 4, 6 and 8TB, the Seagate NAS drives are aimed at those who want extra reliability, without the higher cost of enterprise solutions. Compared to the Seagate desktop drives, the NAS drive costs about 16% more, but has a three-year warranty. The NAS drives are actually a tiny bit slower, but offer a much larger 180TB per year endurance, vs 55 for the desktop drives. They are also over 30% cheaper than the Enterprise drives.

The basic Seagate NAS drives have been effectively absorbed into the IronWolf line-up but, for now, are cheaper for essentially the same spec. The drives are not the fastest, but offer more than enough performance for NAS use.

Verdict

The cheapest (per TB) NAS rated HDD available, that still offers quite good reliability figures.

★★★★½

Capacity: 4, 6, 8TB; **RPM:** 7,200rpm; **Cache:** 128MB; **Endurance:** 550TB a year; **MTBF:** 2 / 2.5 million hours; **Dollars per TB:** $107–$112; **Warranty:** 5 years

$429 (4TB)
WWW.WDC.COM

Western Digital Gold

For very high-end data storage.

Twice as expensive (per TB) as the cheapest WD Red NAS HDDs, the Gold drives designed for professional use where hard-working reliability is key. The 550TB endurance per year and 2.5 million hour MTBF is around double a lot of the competition, so you get what you pay for. The Gold drives also include premium 24/7 support and a five-year warranty. The drives are available in 4, 6 and 8TB (as tested) capacities, running at 7,200rpm with 128MB of cache. Interestingly, all three variants are fairly similar in price per TB.

While the drives can work 24/7, they don't actually offer better performance, and cap out at similar maximum transfer rates to more affordable drives.

Verdict

Worth the extra cost if absolute reliability and support is most important.

★★★★☆

Capacity: 1, 2, 3, 4, 6, 8TB; **RPM:** 5,400rpm; **Cache:** 64 / 128MB; **Endurance**: Not given; **MTBF:** Not given; **Dollars per TB:** $55–$90; **Warranty:** 3 years

$227 (4TB)
WWW.WDC.COM

Western Digital Purple

Designed for video applications.

An increasingly common use for a NAS is video surveillance. The thing is, recording video is different to normal data storage, and pure NAS drives are not always up to the task. The WD drives are rated for 24/7 operation with very low vibration, at slightly higher peak temperatures. In the Purple series, WD includes AllFrame technology, which works to reduce frame loss and pixelation, to ensure the best video quality. The drives also support large arrays up to eight NAS bays, recording from 32 cameras.

It's all about trade-offs, though, so the Purple series has mildly lower MB/s performance figures on some drives to keep prices down, and don't actually provide a MTBF rating.

Verdict

A capable drive for NAS IP camera recordings, without any extra cost per TB.

★★★★½

Capacity: 1, 2, 3, 4, 6, 8TB; **RPM:** 5,400rpm; **Cache:** 64 / 128MB; **Endurance:** Not given; **MTBF:** 1 million hours; **Dollars per TB:** $53–$90; **Warranty:** 3 years

$230 (4TB)
WWW.WDC.COM

Western Digital Red

Available as both a standard and Pro model.

Aimed at home and office NAS use, the WD Red drives are a mixture of necessary features and affordability. The HDDs are available from 1 through to 8TB, with a 3.5-inch form factor, 5,400rpm and supporting up to eight bays. 3TB is the best value for money. For normal NAS use, performance is fine, though not as good as more expensive models.

The Red drives are rated at 1 million hours MTBF and have a three-year warranty. There are also 2.5-inch models, in 750GB and 1TB, but almost double the price.

To support up to 16 NAS bays with better throughput, the Red drives have a Pro version (with a five-year warranty) but they cost about 50% more.

Verdict

A solid entry-level NAS drive, with plenty of options to upgrade to higher-end models.

★★★½

2.5-INCH NAS HDD

Capacity: 1, 2TB; **RPM:** 7,200rpm; **Cache:** 128MB; **Endurance:** Not given; **MTBF:** 2 million hours; **Dollars per TB:** $315; **Warranty:** 5 years

$620 (2TB)
WWW.SEAGATE.COM

Seagate Enterprise Capacity 2.5" v3

For unique applications.

A surprisingly large amount of NAS support 2.5" drives, but is there a reason to use them? The Enterprise Capacity comes in 1 and 2TB models (and SAS or SATA), and offers a high 2 million hour MTBF and five-year warranty. They spin at 7,200rpm and have 128MB of cache. While 2.5" models use about a third less power than comparable 3.5" models and are a little quieter, they cost at least three times more. They also offer lower performance, but still plenty for most NAS use.

Another factor is the reduced size, but at a maximum of 2GB, they don't offer the same data density.

Still, for certain applications, a 2.5" Enterprise NAS drive can be worth the price.

Verdict

Very expensive per TB, but still useful for niche applications.

★★★½

"While SSDs offer higher-end performance, NAS are typically limited by the Gigabit Ethernet connection throughput, not drive speed."

NAS SSDs

They're not the first option many think of, but you can use an SSD in your NAS too.

Traditionally, SSDs have been too expensive to be worth using in a NAS, and often have relatively poor endurance ratings. But as SSDs fall in price, some companies have enterprise-rated models for use in storing data. Some new NAS even use M.2 form factor SSDs, which can squeeze an entire NAS into a router-sized package. While SSDs offer higher-end performance, NAS are typically limited by the Gigabit Ethernet connection throughput, not drive speed. Mechanical HDDs are also often teamed up in RAID, for higher speeds, as well as redundancy. SSDs can improve random access with small file sizes, and are handy in a NAS running some apps. SSDs can also have lower power use and heat production, and various NAS support the 2.5-inch form factor.

While an enterprise-rated SSD is ideal, certain more affordable consumer models can also have decent endurance, and offer long warranties for peace of mind. With that in mind, we tested two different SSDs for NAS use – one consumer, one enterprise. For (most) consumer NAS use, a SATA interface is used, so faster PCIe drives are no use.

Unless you write huge amounts of data, the endurance of most SSDs is enough for data backup and access. Despite a relatively low rating, drives such as the Samsung 840 Pro have been tested to survive through over 2,000TB of data written. Keep in mind, though, many consumer drive warranties won't cover use outside of a normal PC.

Capacity: 128, 256, 512, 1024GB; **Endurance:** Up to 1,600 TBW; **MTBF:** 1 million hours; **Dollars per TB:** $480–$920; **Warranty:** 5 years

$480 (512GB)
WWW.KINGSTON.COM

Kingston SSDNow KC400

A business-focused SSD.

The KC400 is available in 128, 256, 512GB and 1TB capacities – all using the same 2.5-inch form factor and SATA III interface. The sweet spot is the 512GB drive, but the larger 1TB model is not that much more expensive per TB. The drives have an excellent 1 million hour MTBF, five-year warranty and a TBW of up to 1,600TB (320TB a year) – on par with most mid-range enterprise NAS HDDs.

The Kingston drive is faster than a mechanical HDD, but for NAS use, Ethernet speed limits mean SSDs main advantage is for small random data access. The downside, of course, is the price – per TB, the KC400 is almost 10 times as expensive as its mechanical cousins.

Verdict

A fast and reliable business SSD that, while expensive, is a decent choice for NAS use.

★★★★☆

Capacity: 120, 250, 500, 1000, 2,000GB; **Endurance:** Up to 150 TBW, **MTBF:** 1.5 million hours; **Dollars per TB:** $415–$759; **Warranty:** 5 years

$415 (1TB)
WWW.SAMSUNG.COM

Samsung 850 EVO

Available in both 2.5-inch and M.2 form factors.

A consumer drive using Samsung's 3D NAND, the 850 EVO is available in sizes up to 2TB. The SSD has an excellent 1.5 million hour MTBF and a five-year warranty, but a rather low 150 TBW. Still, that's over 80GB per day, for the entire warranty. The 1TB model is the best value, but the 500GB and 2TB drives have a very similar cost per TB – the 120GB is best avoided.

The drive is lightning fast, but the extra performance doesn't really matter much for NAS use. Having a M.2 option is fantastic, and new mini-NASs are starting to appear that use the small factor SSDs. Stepping up to the 850 Pro boosts the MTBF to 2 million hours and the warranty out to 10 years, for about an extra $150 per TB.

Verdict

A fast SSD with M.2 option, best suited to lower data access applications.

★★★★☆

NAS HARD DRIVE BENCHMARK RESULTS

3.5-INCH NAS DRIVES

MANUFACTURER	DRIVE FAMILY	CAPACITY TB	CRYSTALDISKMARK SEQUENTIAL READ (MB/S)	CRYSTALDISKMARK SEQUENTIAL WRITE (MB/S)	CRYSTALDISKMARK RANDOM READ (MB/S)	CRYSTALDISKMARK RANDOM WRITE (MB/S)	NAS READ (MB/S)*	NAS WRITE (MB/S)*
HGST	DESKSTAR NAS	4	159.8	167.8	0.58	1.61	103.2	103.1
SEAGATE	ENTERPRISE NAS	6	172.5	171.2	0.69	1.67	102.9	105.6
SEAGATE	ENTERPRISE NAS	8	178.9	171.4	0.76	1.68	103.2	101.6
SEAGATE	IRONWOLF	10	171.4	169.9	0.54	1.59	102.4	104.5
SEAGATE	NAS	4	162.5	160.3	0.48	1.54	101.7	102.7
WESTERN DIGITAL	GOLD	8	177.8	171.4	0.67	1.66	103.2	107.8
WESTERN DIGITAL	PURPLE	2	122.4	118.7	0.49	1.47	99.7	101.2
WESTERN DIGITAL	RED	6	160.7	157.1	0.61	1.51	103.1	106.4
WESTERN DIGITAL	RED	8	161.3	156.2	0.61	1.49	103.2	105.4

2.5-INCH NAS DRIVES AND SSDS

MANUFACTURER	MODEL NAME	CAPACITY TB	CRYSTALDISKMARK SEQUENTIAL READ (MB/S)	CRYSTALDISKMARK SEQUENTIAL WRITE (MB/S)	CRYSTALDISKMARK RANDOM READ (MB/S)	CRYSTALDISKMARK RANDOM WRITE (MB/S)	NAS READ (MB/S)*	NAS WRITE (MB/S)*
SEAGATE	ENTERPRISE 2.5"	2	111.2	114.6	0.51	0.55	99.8	97.1
KINGSTON	SSDNOW KC400	256	521.4	509.8	42.7	121.3	103.8	106.4
SAMSUNG	850 EVO	250	520.1	499.6	41.5	119.8	104.3	105.1

*TESTED WITH TWO DRIVES IN A QNAP TS-251+ IN RAID 0. FOR ALL OTHER CRYSTALDISKMARK TESTS, DRIVES WERE PLUGGED DIRECTLY INTO A DESKTOP PC.

NAS HARD DRIVE SPECIFICATIONS

3.5-INCH MECHANICAL NAS DRIVES

MANUFACTURER	DRIVE FAMILY	CAPACITY TB	PRICE $	CENTS PER GB	RPM	CACHE MB	ENDURANCE (TB PER YEAR)	MTBF (MILLION HOURS)	WARRANTY
HGST	DESKSTAR NAS	3	195	6.5	7200	64	N/S	1	3 YEARS
HGST	DESKSTAR NAS	4	250	6.3	7200	128	N/S	1	3 YEARS
HGST	DESKSTAR NAS	6	390	6.5	7200	128	N/S	1	3 YEARS
SEAGATE	ENTERPRISE NAS	2	195	9.8	7200	128	300	1.2	5 YEARS
SEAGATE	ENTERPRISE NAS	3	250	8.3	7200	128	300	1.2	5 YEARS
SEAGATE	ENTERPRISE NAS	4	260	6.5	7200	128	300	1.2	5 YEARS
SEAGATE	ENTERPRISE NAS	5	390	7.8	7200	128	300	1.2	5 YEARS
SEAGATE	ENTERPRISE NAS	6	450	7.5	7200	128	300	1.2	5 YEARS
SEAGATE	ENTERPRISE NAS	8	715	8.9	7200	256	300	1.2	5 YEARS
SEAGATE	IRONWOLF	2	125	6.3	5900	64	180	1	3 YEARS
SEAGATE	IRONWOLF	3	160	5.3	5900	64	180	1	3 YEARS
SEAGATE	IRONWOLF	4	205	5.1	5900	64	180	1	3 YEARS
SEAGATE	IRONWOLF	6	379	6.3	7200	128	180	1	3 YEARS
SEAGATE	IRONWOLF	8	565	7.1	7200	256	180	1	3 YEARS
SEAGATE	IRONWOLF	10	749	7.5	7200	256	180	1	3 YEARS
SEAGATE	NAS	2	115	5.8	5900	64	180	1	3 YEARS
SEAGATE	NAS	3	150	5.0	5900	64	180	1	3 YEARS
SEAGATE	NAS	4	200	5.0	5900	64	180	1	3 YEARS
SEAGATE	NAS	6	385	6.4	7200	128	180	1	3 YEARS
SEAGATE	NAS	8	550	6.9	7200	256	180	1	3 YEARS
WESTERN DIGITAL	GOLD	4	429	10.7	7200	128	550	2	5 YEARS
WESTERN DIGITAL	GOLD	6	680	11.3	7200	128	550	2	5 YEARS
WESTERN DIGITAL	GOLD	8	899	11.2	7200	128	550	2.5	5 YEARS
WESTERN DIGITAL	PURPLE	1	90	9.0	5400	64	N/S	N/S	3 YEARS
WESTERN DIGITAL	PURPLE	2	125	6.3	5400	64	N/S	N/S	3 YEARS
WESTERN DIGITAL	PURPLE	3	165	5.5	5400	64	N/S	N/S	3 YEARS
WESTERN DIGITAL	PURPLE	4	227	5.7	5400	64	N/S	N/S	3 YEARS
WESTERN DIGITAL	PURPLE	6	400	6.7	5400	64	N/S	N/S	3 YEARS
WESTERN DIGITAL	PURPLE	8	499	6.2	5400	128	N/S	N/S	3 YEARS
WESTERN DIGITAL	RED	1	90	9.0	5400	64	N/S	1	3 YEARS
WESTERN DIGITAL	RED	2	130	6.5	5400	64	N/S	1	3 YEARS
WESTERN DIGITAL	RED	3	160	5.3	5400	64	N/S	1	3 YEARS
WESTERN DIGITAL	RED	4	230	5.8	5400	64	N/S	1	3 YEARS
WESTERN DIGITAL	RED	5	330	6.6	5400	64	N/S	1	3 YEARS
WESTERN DIGITAL	RED	6	370	6.2	5400	64	N/S	1	3 YEARS
WESTERN DIGITAL	RED	8	490	6.1	5400	128	N/S	1	3 YEARS

2.5-INCH MECHANICAL NAS DRIVES AND NAS SSDS

MANUFACTURER	MODEL NAME	CAPACITY TB	PRICE $	CENTS PER GB	RPM	CACHE MB	ENDURANCE (TB PER YEAR)	MTBF (MILLION HOURS)	WARRANTY
SEAGATE	ENTERPRISE 2.5"	1	320	32.0	7200	128	N/S	2	5 YEARS
SEAGATE	ENTERPRISE 2.5"	2	620	31.0	7200	128	N/S	2	5 YEARS
KINGSTON	SSDNOW KC400	128	115	90	N/A	N/S	30	1	5 YEARS
KINGSTON	SSDNOW KC400	256	140	55	N/A	N/S	60	1	5 YEARS
KINGSTON	SSDNOW KC400	512	240	47	N/A	N/S	160	1	5 YEARS
KINGSTON	SSDNOW KC400	1024	550	54	N/A	N/S	320	1	5 YEARS
SAMSUNG	850 EVO	120	89	74	N/A	512	30	1.5	5 YEARS
SAMSUNG	850 EVO	250	119	48	N/A	512	30	1.5	5 YEARS
SAMSUNG	850 EVO	500	204	41	N/A	512	30	1.5	5 YEARS
SAMSUNG	850 EVO	1000	405	41	N/A	512	30	1.5	5 YEARS
SAMSUNG	850 EVO	2000	830	42	N/A	512	30	1.5	5 YEARS

6/8/12-bay Turbo vNAS

TVS-x82 Series

Tiered Storage, Application-based Partitioning and Network Traffic Distribution

Tiered Storage for optimal storage efficiency

QNAP's Qtier Technology empowers the TVS-x82 series with Auto Tiering to improve performance and utilization of your entire storage infrastructure across M.2 SSD, SSD, PCIe NVMe SSD, and SATA.

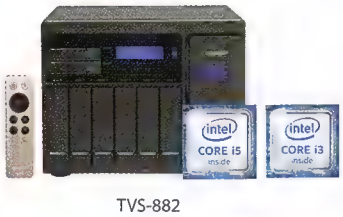
Application-based Partitioning for optimized throughput

The TVS-x82 series fully supports three types of storage media: M.2, SSD, and SATA hard drives that can be configured as independent partitions for different applications, ensuring the optimum throughput level for each application.

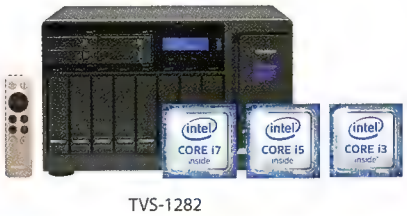
Network Traffic Distribution for network resources enhancement

The TVS-x82 series has four built-in Gigabit Ethernet ports and two built-in 10 Gigabit Ethernet ports enabling applications to use dedicated interfaces for ideal network traffic management and distribution.

TVS-682



TVS-882



TVS-1282

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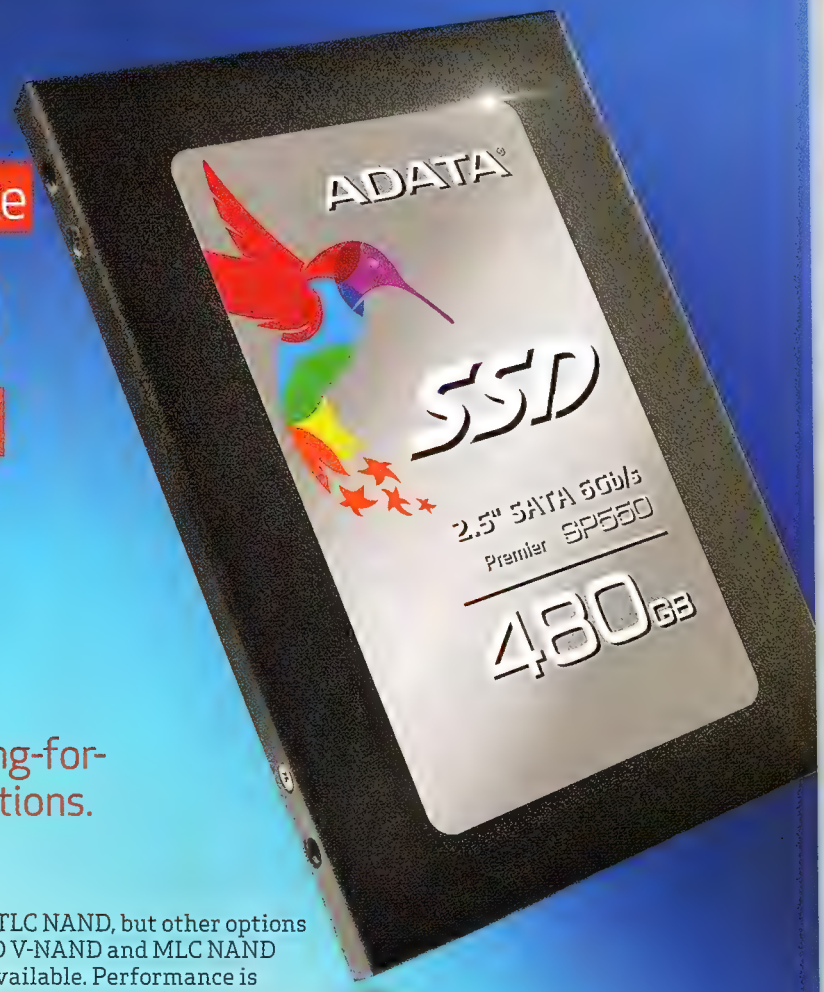
"We took 12 drives available right now with a cost (in at least one capacity) of under $0.50 per GB and put them to the test."



SSDs on a budget

Lindsay Handmer compares bang-for-buck laptop and PC upgrade options.

Buying an affordable SSD is an easy way to boost performance compared to a mechanical HDD, but what do you actually get for your money? We took 12 drives available right now with a cost (in at least one capacity) of under $0.50 per GB and put them to the test.

It's worth noting that many of the best deals are SSDs launched in 2015, which have since dropped in price, but some new drives are even better value. All use the SATA III interface (no PCIe), and are mostly in the 2.5-inch, 7mm-thick form factor, with a few SATA M.2 options. We tested drives around 120GB, 240GB and 500GB (and a few in between), and the prices (generally) get cheaper per GB the larger you go.

Most use TLC NAND, but other options such as 3D V-NAND and MLC NAND also are available. Performance is generally pretty similar (and somewhat capped by SATA speeds) but different models do eke out a little extra (or sometimes less), especially with large files sizes and random read and writes. Performance is significantly lower than PCIe based SSDs, but is more than enough for most budget builds.

Extra features are few, and the main ones to look out for are hardware-based encryption support, and very low idle power draws which prolong battery life in laptop usage. Another factor is the endurance rating (typically Total Bytes Written) – but all the drives tested are more than rated for normal use.

HOW WE TESTED

The drives were benchmarked as a secondary drive on a budget build PC, and while there is some variation, all performed well for affordable SSDs. Keep in mind that different capacity drives can have varying performance. Sequential read and writes show peak speeds, which are mostly constrained by the cache, SATA interface and controller efficiency. 4K Random speeds show more varied access, such as booting up. AS SSD Program copy shows sustained speeds, such as when copying large files or moving games.

BUDGET SSDs TEST RESULTS

	AS SSD SEQ READ / WRITE MB/S	AS SSD 4K READ / WRITE MB/S	AS SSD PROGAM COPY MB/S	CRYSTALDISKMARK SEQUENTIAL READ / WRITE MB/S	CRYSTALDISKMARK 4K RANDOM READ / WRITE MB/S
SSDS ~120GB					
INTEL 535 SERIES (M.2) 120GB	509.8 / 450.2	25.9 / 115.5	261	502.8 / 421.8	37.5 / 101.2
OCZ TRION 150 120GB	513.9 / 412.5	25.4 / 102.4	254.6	502.3 / 511.2	32.1 / 99.0
SSDS ~ 250GB					
ADATA SP550 240GB	524.3 / 487.1	27.6 / 95.6	274.5	509.6 / 458.0	25.4 / 82.1
KINGSTON HYPERX SAVAGE 240GB	532.2 / 511.8	35.4 / 135.9	281.7	518.4 / 505.8	44.3 / 115.6
SAMSUNG 750 EVO 250GB	521.2 / 497.7	38.1 / 102.5	256.9	519.2 / 499.8	41.5 / 114.4
SANDISK ULTRA II 240GB	505.3 / 462.7	29.7 / 89.7	244.1	518.4 / 475.4	31.3 / 115.8
SILICON POWER S60 240GB	468.2 / 308.1	27.9 / 85.1	220.4	515.7 / 314.0	23.4 / 93.5
TRANSCEND SSD220S 240GB	502.3 / 451.0	30.4 / 131.2	249.7	497.4 / 444.3	27.8 / 111.8
SSDS ~500GB					
CRUCIAL MX300 (2.5-INCH) 750GB	528.5 / 510.0	38.9 / 125.1	315.7	496.0 / 492.4	29.4 / 125.9
KINGSTON UV400 (2.5-INCH) 480GB	517.6 / 497.2	33.2 / 105.0	321.5	512.6 / 498.6	35.1 / 121.5
OCZ TRION 100 (2.5-INCH) 480GB	535.3 / 514.0	27.8 / 70.1	242.5	522.3 / 510.8	33.2 / 65.8
SAMSUNG 850 EVO (2.5-INCH) 480GB	519.7 / 498.2	36.2 / 116.4	281.6	520.2 / 495.9	40.8 / 120.0

SSDs AROUND 120GB

Form factor: 2.5" / M.2 2280; **Capacity:** 120, 180, 240, 360, 480GB; **TBW:** 73TB; **Warranty:** 5 years; **Weight:** 78g / 28g

$60 (120GB) | WWW.INTEL.COM

Intel SSD 535 Series

Available in both 2.5-inch and M.2.

Unlike most SSDs, the Intel 535 Series comes with an extra-large range of capacities, and in both M.2 and 2.5-inch form factors. While you can grab the drives in the normal 120, 240 and 480GB sizes, it also comes in 360GB and 180GB – though these latter two offer much poorer prices per GB and are best avoided.

The 120GB and 240GB drives are available using M.2, and offer around the same price per GB as their 2.5-inch brethren. The largest 480GB drive is only available in the 2.5-inch form factor, and has the best price per GB.

The Intel 535 Series uses 16nm MLC NAND and a SandForce 2281 controller. Performance is excellent and very similar for all the capacities, but the older controller struggles with large incompressible files. Intel rates the drive for 40GB a day (73TB TBW) over the longer-than-most five-year warranty.

Verdict

A decent drive available in a wide range of formats and capacities, though some lack value.

★★★½☆

SSDs AROUND 120GB

Form factor: 2.5" SATA; **Capacity:** 120, 240, 480, 960GB; **TBW:** 240TB max; **Warranty:** 3 years; **Weight:** 61g

$60 (120GB) | WWW.OCZ.COM

OCZ Trion 150

Is this your new SSD?

Using Toshiba 15nm TLC NAND, the Trion 150 is a low-cost SSD that aims to provide excellent performance. It has the usual 2.5-inch form, a SATA III interface and a Toshiba controller.

Like most of the competition, the OCZ Trion 150 is available in 120, 240, 480 and 960GB capacities. Of course, the best value per GB is the largest drive, but the smaller models also offer strong bang for buck. Performance is excellent (maxing out the SATA connection), though the lower capacities have reduced writes speeds.

It has a TDW of 240TB for the 960GB drive, which drops to 120TB, 60TB and 30TB in the 480, 240 and 120GB SSDs. The SSDs are backed by a three-year warranty, so the endurance is plenty.

Importantly for laptop users, the Trion 150 supports DevSLP, with a max 10mW power draw, or 100mW when idle, and up to a max of 3.6W when actively writing.

Verdict

A fast and decently featured SSD that is still very affordable.

★★★★☆

SSDs AROUND 250GB

Form factor: 2.5" SATA; **Capacity:** 120, 240, 480, 960GB; **TBW:** Not given; **Warranty:** 3 years; **Weight:** 47.5g

$90 (240GB) | WWW.ADATA.COM

ADATA SP550

Good bang for buck.

Launched locally this year, the SP550 is a standard 2.5-inch, 7mm-thick SSD with a focus on affordability whilst still giving solid performance.

The drive uses a Silicon Motion SM2256 controller, coupled up to SK Hynix 16nm TLC NAND. It's available in 120, 240, 480 and 960GB models, the SP550 gets cheaper in the larger capacities, but still boasts one of the better 120GB prices available. And at just an extra $30 to double the size to 240GB, it's worth going big.

Performance is quite good; actually slightly better in 240GB and 480GB. Random reads are better than the writes, but similar to the competition. The drive does not support encryption, but does support low power states for use in laptops. While no endurance levels are given, it will be more than enough for normal use. The free ADATA SSD Toolbox is also a nice bit of software for managing the drive.

Verdict

While not standout in any way, the SP550 gives solid performance for a good price.

★★★½☆

Form factor: 2.5" SATA; **Capacity:** 120, 240, 480, 960GB; **TBW:** Up to 681TB; **Warranty:** 3 years; **Weight:** 68g

$118 (240GB) | WWW.KINGSTON.COM

Kingston HyperX Savage

Need an MLC SSD?

Launched back in 2015, the Kingston HyperX Savage was originally targeted as a mid-range drive, rather than being 'affordable'. Since then, price drops have put it solidly into the budget range. The drive uses a 2.5-inch, 7mm-thick form, a SATA III interface and is available in 120, 240, 480 and 960GB capacities. Under the hood, it has a Phison S10 controller, along with Toshiba A19 MLC NAND.

The result is performance that is noticeably faster than the TLC competition, especially with an almost full drive. It also excels at random reads and writes, though the 120GB drive is significantly slower (and has a fairly poor price per GB). The 240GB model is okay value, but the 480GB SSD (at under $200) is the best by far. The Savage has up to 681TB TBW on the 960GB, dropping down to 416TB on the 480GB, 306TB on the 240GB and 113TB on the 120GB drive.

Verdict

A very fast, yet still affordable, MLC-based drive that lacks a few of the features found in cheaper options.

★★★★½

Form factor: 2.5" SATA; **Capacity:** 120, 250GB; **TBW:** 35, 70TB; **Warranty:** 3 years; **Weight:** 45g

$103 (250GB) | WWW.SAMSUNG.COM/AU

Samsung 750 EVO

Samsung's more value-orientated SSD.

Newly launched earlier in 2016, the 750 EVO aims to be a lower cost version of the excellent 850 EVO, using the same 2.5-inch SATA II form factor and interface, but it's only available in 120GB and 250GB. Interestingly, while the drive does use a Samsung MGX controller, it does not use 3D NAND, rather a standard 16nm TLC NAND. The idea here is to drive the price lower. The 120GB drive has a 35TB endurance, while the 250GB offers 70TB. In comparison, the 850 EVO has a 75TB endurance.

In both the 120GB the 250GB capacities, the 750 EVO is about $20 cheaper than the 850 EVO, which is a decent budget saving. Importantly, it also competes well against other TLC-based SSDs, and offers comparable and often better real-world performance.

Handily, the 750 EVO supports both hardware-based encryption and low power states.

Verdict

An excellent all round SSD with decent features considering the price.

★★★★½

Form factor: 2.5" SATA; **Capacity:** 120, 240, 480, 960GB; **TBW:** Not given; **Warranty:** 3 years; **Weight:** 58g

$99 (240GB) | WWW.SANDISK.COM

SanDisk Ultra II

Available in a wide range of sizes.

SanDisk's first TLC-based SSD, the Ultra II, has dropped significantly in price since launch and is now quite affordable. The notable exception is the 120GB model, which is significantly more expensive per GB than the larger 240 (as tested), 480 and 960GB drives.

The SSD is a 2.5-inch, 7mm SATA III-based drive that uses the Marvell 88SS9190 controller, and performance is great. The Ultra II offers comparable sequential performance across the available capacities, but random access speeds are slightly better on the larger models. SanDisk does not provide an endurance rating for the drive, but long-term testing shows it to be similar to competing TLC SSDs. As an older model, the Ultra II does not support DevSLP for low power applications, or hardware based encryption.

The slightly cheaper SSD Plus is another decent SSD from SanDisk.

Verdict

An affordable drive that lacks a few features, but still offers decent bang for buck.

★★★½

480GB+ SSDs

Form factor: 2.5" SATA; **Capacity:** 120, 240, 480GB; **TBW:** 650TB; **Warranty:** 3 years; **Weight:** 63g

$98 (240GB) | WWW.SILICON-POWER.COM

Silicon Power S60

Opt for a lesser known brand and save.

The Silicon Power S60 aims to provide decent performance at a very affordable price. It's available in 120GB, 240GB and 480GB. The price has dropped a lot since launch, but the S60 is only really competitive in cost per GB metric when buying the 240GB (as tested) model.

The Silicon Power SSD uses a SandForce SF-2281 controller paired up with Intel NAND. It's a bog standard 2.5-inch drive, and measures in at 7mm thick and weighs 63 grams. However, as a last-gen budget SSD, it doesn't have support for low power states or hardware-based encryption.

All things considered, sequential performance is pretty good, and it easily keeps up with the competition. Random 4K read and writes are a bit slower than some, but still acceptable. The S60 is also backed by a three-year warranty, but does not provide the endurance rating.

Verdict

Okay performance and price, but better options exist.

★★★★☆

Form factor: 2.5" SATA; **Capacity:** 120, 240, 480GB; **TBW:** Not given; **Warranty:** 3 years; **Weight:** 58g

$82 (240GB) | WWW.TRANSCEND-INFO.COM

Transcend SSD220s

Shopping for a very cheap SSD?

This 2.5-inch SATA III SSD measures in at just 6.8mm thick. It's available in 120GB, 240GB and 480GB models. The SSD uses a Silicon Motion SM2256KAB controller, paired up with 16nm TLC NAND. Like most drives, the 120GB SSD220s is more expensive per GB than its larger brethren, but for as little as $53, it's one of the cheapest at that capacity. The 240GB and 480GB are even more affordable.

The SSD220s performs pretty well, and works hard to get the most from a SATA III connection. Read speeds are up there with the best, though writes are a bit slower. The Transcend SSD is backed by a 3-year warranty, though does not provide an endurance rating. It also supports AES 256-bit encryption, as well as low power DevSLP. Transcend provides a free utility that makes it easy to manage the SSD, as well as clone your old drive.

Verdict

A very cheap 120GB upgrade, but still some of the best value around in the larger sizes.

★★★★☆

Form factor: 2.5" SATA; **Capacity:** 750GB; **TBW:** 220TB; **Warranty:** 3 years; **Weight:** 55g

$300 | WWW.CRUCIAL.COM

Crucial MX300

A unique contender with a lot to love.

Unlike the other SSDs tested, the Crucial MX300 currently comes in just one size – 750GB, at 2.5 inches. While this capacity is not normally seen, it fills in the gap between the more common 480 and 960GB drives. (Other sizes and M.2 form factors should be available later in the year.) Plus, the MX300 costs a very low $0.40 per GB.

The MX300 uses Micron's new 32-layer 3D TLC NAND, run by a Marvell 88SS1074 controller. The result is an extremely fast drive which is on par with the competition, and pushes the SATA III connection to its limits. It has a TBW of 220TB, which is about on par with other large TLC SSDs and is backed by a three-year warranty.

The MX300 supports both AES 256-bit encryption and DevSLP power modes, so is perfect for use in a laptop. Power draw is as low as 4mW, and peaks at 5.2W when writing.

Verdict

A useful capacity that is still affordable while offering top-notch performance.

★★★★☆

Form factor: 2.5" SATA; **Capacity:** 120, 240, 480GB; **TBW:** 200TB; **Warranty:** 3 years; **Weight:** 57g

$150 (480GB) | WWW.KINGSTON.COM

Kingston SSDNow UV400

An affordable upgrade.

Packaged in the standard 7mm thick 2.5-inch enclosure, the Kingston UV400 uses a SATA III interface. Handling those ones and zeroes is a Marvell 88SS1074 controller, coupled up to Toshiba 15nm TLC NAND. Available in 120, 240 and 480GB capacities, the UV400 offers an excellent cost, as low as $0.31 per GB for the largest size.

In the 480GB capacity, it has the lowest price per GB of any drive tested. Even the 120GB drive is great value, at just $50. Performance is excellent, though the 120GB and 240GB drives have slightly lower writes. It has a three-year warranty, and a quite good TBW of 200TB for the 480GB drive, 100TB for the 240GB drive and 50TB for the 120GB drives.

Important to note is that the drive does not support DevSLP (low power mode) so is best avoided for laptop use. It also doesn't handle hardware encryption.

Verdict

A very affordable drive with excellent performance, though best suited to a desktop PC.

★★★★½

Form factor: 2.5" SATA III; **Capacity:** 120, 240, 480, 960GB; **TBW:** 240TB; **Warranty:** 3 years; **Weight:** 48g

$169 (480GB) | WWW.OCZ.COM

OCZ Trion 100

Is it worth going for the older drive?

While we tested the latest Trion 150 (page 61), the older Trion 100 is still widely available. Perhaps more importantly for budget buyers, it's actually slightly cheaper – aside from the 120GB model. It's available in 960, 480, 240 and 120GB models. The Trion 100 is built on Toshiba TLC NAND, paired up with a Toshiba TC58 controller, and all packaged up in the usual 2.5-inch, 7mm-thick SATA III form factor.

The newer Trion 150 is slightly faster than the older 100 for large file copies, but the differences are fairly small. The OCZ SSD does a pretty decent job of maxing out the SATA interface, but random writes are a bit slower than ideal. As expected, the larger capacity drives have a slightly faster write speed, but not hugely so. The Trion 100 is backed by a three-year warranty, and has a TBW of up to 240TB – or about 219GB per day.

Verdict

A slightly older drive that still offers decent performance considering the price.

★★★½☆

Form factor: 2.5", M.2, SATA; **Capacity:** 120, 250, 500, 1,000, 2,000GB; **TBW:** 150TB; **Warranty:** 5 years; **Weight:** 66g

$200 (500GB) | WWW.SAMSUNG.COM/AU

Samsung 850 EVO

Can other SSDs compete?

Launched early 2015 in Australia, the Samsung 850 EVO aims to create an ideal balance between performance, features and price. The SSD uses 32-layer 3D V-NAND, and is available in 120, 250, 500, 1,000 and 2,000GB capacities. It uses both 2.5-inch and M.2 form factors, both using the SATA III interface – though the 1,000 and 2,00GB model are 2.5-inch only.

The 120GB models are fairly poor value compared to the larger capacities, though the price per GB for both the 500GB and 1,000GB models is the same – good news for an affordable upgrade.

As expected, performance is quite good, and the 850 EVO is worthy of your upgrade dollars. The drives are backed by a five-year warranty, with a TBW of up to 150TB on the larger capacities. It also supports both low power modes and hardware encryption.

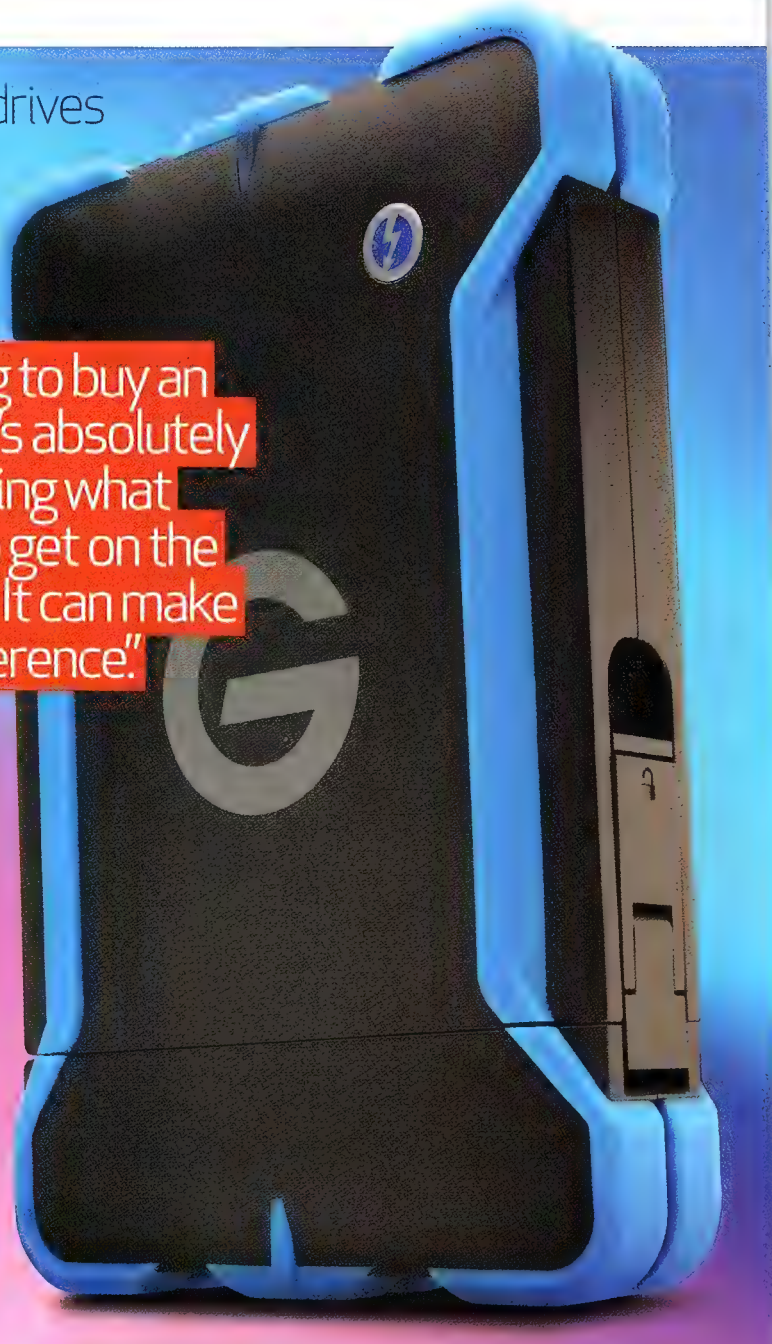
Verdict

A very fast yet affordable SSD available in a huge array of capacities and both M.2 and 2.5-inch form factors.

★★★★½

BUDGET SSDs SPECIFICATIONS

	PRICE	CAPACITY (GB)	COST PER GB	CONTROLLER	NAND	TDW TB	GB PER DAY	WAR-RANTY	LOW POWER MODE	HARDWARE ENCRYPTION
SSDS ~120GB										
INTEL 535 SERIES (2.5-INCH)	68	120	0.57	SANDFORCE 2281	16NM MLC NAND	73	40	5 YEARS	YES	YES
INTEL 535 SERIES (2.5-INCH)	175	180	0.97	SANDFORCE 2281	16NM MLC NAND	73	40	5 YEARS	YES	YES
INTEL 535 SERIES (2.5-INCH)	108	240	0.45	SANDFORCE 2281	16NM MLC NAND	73	40	5 YEARS	YES	YES
INTEL 535 SERIES (2.5-INCH)	293	360	0.81	SANDFORCE 2281	16NM MLC NAND	73	40	5 YEARS	YES	YES
INTEL 535 SERIES (2.5-INCH)	200	480	0.42	SANDFORCE 2281	16NM MLC NAND	73	40	5 YEARS	YES	YES
INTEL 535 SERIES (M.2)	60	120	0.50	SANDFORCE 2281	16NM MLC NAND	73	40	5 YEARS	YES	YES
INTEL 535 SERIES (M.2)	163	180	0.91	SANDFORCE 2281	16NM MLC NAND	73	40	5 YEARS	YES	YES
INTEL 535 SERIES (M.2)	109	240	0.45	SANDFORCE 2281	16NM MLC NAND	73	40	5 YEARS	YES	YES
INTEL 535 SERIES (M.2)	190	360	0.53	SANDFORCE 2281	16NM MLC NAND	73	40	5 YEARS	YES	YES
OCZ TRION 150 (2.5-INCH)	60	120	0.50	TOSHIBA TC58	TOSHIBA 15NM TLC	30	27	3 YEARS	YES	NO
OCZ TRION 150 (2.5-INCH)	90	240	0.38	TOSHIBA TC58	TOSHIBA 15NM TLC	60	55	3 YEARS	YES	NO
OCZ TRION 150 (2.5-INCH)	185	480	0.39	TOSHIBA TC58	TOSHIBA 15NM TLC	120	110	3 YEARS	YES	NO
OCZ TRION 150 (2.5-INCH)	350	960	0.36	TOSHIBA TC58	TOSHIBA 15NM TLC	240	219	3 YEARS	YES	NO
SSDS ~ 250GB										
ADATA SP550 (2.5-INCH)	60	120	0.50	SILICON MOTION SM2256	SK HYNIX 16NM TLC NAND	N/S	N/A	3 YEARS	YES	NO
ADATA SP550 (2.5-INCH)	90	240	0.38	SILICON MOTION SM2256	SK HYNIX 16NM TLC NAND	N/S	N/A	3 YEARS	YES	NO
ADATA SP550 (2.5-INCH)	165	480	0.34	SILICON MOTION SM2256	SK HYNIX 16NM TLC NAND	N/S	N/A	3 YEARS	YES	NO
ADATA SP550 (2.5-INCH)	330	960	0.34	SILICON MOTION SM2256	SK HYNIX 16NM TLC NAND	N/S	N/A	3 YEARS	YES	NO
KINGSTON HYPERX SAVAGE (2.5-INCH)	85	120	0.71	PHISON S10	TOSHIBA A19 MLC NAND	113	103	3 YEARS	NO	NO
KINGSTON HYPERX SAVAGE (2.5-INCH)	118	240	0.49	PHISON S10	TOSHIBA A19 MLC NAND	306	279	3 YEARS	NO	NO
KINGSTON HYPERX SAVAGE (2.5-INCH)	199	480	0.41	PHISON S10	TOSHIBA A19 MLC NAND	416	380	3 YEARS	NO	NO
KINGSTON HYPERX SAVAGE (2.5-INCH)	452	960	0.47	PHISON S10	TOSHIBA A19 MLC NAND	681	622	3 YEARS	NO	NO
SAMSUNG 750 EVO (2.5-INCH)	67	120	0.56	SAMSUNG MGX	16NM TLC NAND	35	32	3 YEARS	YES	YES
SAMSUNG 750 EVO (2.5-INCH)	103	250	0.41	SAMSUNG MGX	16NM TLC NAND	75	68	3 YEARS	YES	YES
SANDISK ULTRA II (2.5-INCH)	75	120	0.63	MARVELL 88SS9190	19NM TLC NAND	N/S	N/A	3 YEARS	NO	NO
SANDISK ULTRA II (2.5-INCH)	99	240	0.41	MARVELL 88SS9190	19NM TLC NAND	N/S	N/A	4 YEARS	NO	NO
SANDISK ULTRA II (2.5-INCH)	190	480	0.40	MARVELL 88SS9189	19NM TLC NAND	N/S	N/A	5 YEARS	NO	NO
SANDISK ULTRA II (2.5-INCH)	350	960	0.36	MARVELL 88SS9189	19NM TLC NAND	N/S	N/A	6 YEARS	NO	NO
SILICON POWER S60 (2.5-INCH)	65	120	0.54	SANDFORCE SF-228	INTEL NAND	N/S	N/A	3 YEARS	NO	NO
SILICON POWER S60 (2.5-INCH)	98	240	0.41	SANDFORCE SF-228	INTEL NAND	N/S	N/A	3 YEARS	NO	NO
SILICON POWER S60 (2.5-INCH)	279	480	0.58	SANDFORCE SF-228	INTEL NAND	N/S	N/A	3 YEARS	NO	NO
TRANSCEND SSD220S (2.5-INCH)	53	120	0.44	SILICON MOTION SM2256	16NM TLC NAND	N/S	N/A	3 YEARS	YES	YES
TRANSCEND SSD220S (2.5-INCH)	82	240	0.34	SILICON MOTION SM2256	16NM TLC NAND	N/S	N/A	3 YEARS	YES	YES
TRANSCEND SSD220S (2.5-INCH)	168	480	0.35	SILICON MOTION SM2256	16NM TLC NAND	N/S	N/A	3 YEARS	YES	YES
SSDS ~500GB										
CRUCIAL MX300 (2.5-INCH)	300	750	0.40	MARVELL 88SS1074	MICRON 3D TLC NAND	220	201	3 YEARS	YES	YES
KINGSTON UV400 (2.5-INCH)	50	120	0.42	MARVELL 88SS1074	TOSHIBA 15NM TLC	50	46	3 YEARS	NO	NO
KINGSTON UV400 (2.5-INCH)	80	240	0.33	MARVELL 88SS1074	TOSHIBA 15NM TLC	100	91	3 YEARS	NO	NO
KINGSTON UV400 (2.5-INCH)	150	480	0.31	MARVELL 88SS1074	TOSHIBA 15NM TLC	200	183	3 YEARS	NO	NO
OCZ TRION 100 (2.5-INCH)	62	120	0.52	TOSHIBA TC58	TOSHIBA 19NM TLC	30	27	3 YEARS	YES	NO
OCZ TRION 100 (2.5-INCH)	85	240	0.35	TOSHIBA TC58	TOSHIBA 19NM TLC	60	55	4 YEARS	YES	NO
OCZ TRION 100 (2.5-INCH)	169	480	0.35	TOSHIBA TC58	TOSHIBA 19NM TLC	120	110	5 YEARS	YES	NO
OCZ TRION 100 (2.5-INCH)	315	960	0.33	TOSHIBA TC58	TOSHIBA 19NM TLC	240	219	6 YEARS	YES	NO
SAMSUNG 850 EVO (2.5-INCH)	90	120	0.75	SAMSUNG MGX	32 LAYER 3D V-NAND	75	82	5 YEARS	YES	YES
SAMSUNG 850 EVO (M.2)	89	120	0.74	SAMSUNG MGX	33 LAYER 3D V-NAND	75	41	5 YEARS	YES	YES
SAMSUNG 850 EVO (2.5-INCH)	120	250	0.48	SAMSUNG MGX	34 LAYER 3D V-NAND	75	41	5 YEARS	YES	YES
SAMSUNG 850 EVO (M.2)	124	250	0.50	SAMSUNG MGX	35 LAYER 3D V-NAND	75	41	5 YEARS	YES	YES
SAMSUNG 850 EVO (2.5-INCH)	200	500	0.40	SAMSUNG MGX	36 LAYER 3D V-NAND	150	82	5 YEARS	YES	YES
SAMSUNG 850 EVO (M.2)	207	500	0.41	SAMSUNG MGX	37 LAYER 3D V-NAND	150	82	5 YEARS	YES	YES
SAMSUNG 850 EVO (2.5-INCH)	405	1000	0.41	SAMSUNG MEX	38 LAYER 3D V-NAND	150	82	5 YEARS	YES	YES
SAMSUNG 850 EVO (2.5-INCH)	850	2000	0.43	SAMSUNG MEX	39 LAYER 3D V-NAND	150	82	5 YEARS	YES	YES



"If you're going to buy an external drive, it's absolutely worth knowing what you're going to get on the software front. It can make all the difference."

Storage on the go

Portable hard drives are the most common (and popular) way to add more storage and their compact size means they're easy to take with you

Joel Burgess and Paul Taylor test 12.

Despite many of us relying heavily on the cloud these days, if you're one to keep a lot of videos, photos and music, a hard drive is an indispensable piece of kit. For professional photographers, that hard drive might be a My Passport Wireless Pro that'll wirelessly sync with a camera to store photos as they're taken. Alternatively, for cinematographers who want to work directly off the drive, a portable SSD is probably going to be the best bet. But for most, the affordability and large capacity of portable hard disk drives is hard to pass up.

Following the integration of USB Type-C into the latest high-end ultrabooks, the new cabling standard has finally started to trickle down into external hard drive ranges. USB 3.1 (Type-C) is theoretically capable of carrying twice the data of USB 3.0, but when the older standard is capable of transferring data at 5Gbps, the upgrade is purely for compatibility and perception, offering no real technical boosts to a portable hard drive. Yet, despite the lack of usefulness to this category, many of the pricier models have started including the Type-C connection in their devices. Seagate did manage to put the extra current carrying capacity of the USB Type-C connection to good use, creating the first 3.5-inch external hard drive unit that doesn't require its own power adapter, but in the portable drive space, it seems more of a status symbol still.

With a few new drives in the mix and the landscape changing alongside the decline in price of SSDs, *APC* takes another look at the best portable drives, for keeping your data safe when you're out and about.

HOW WE TESTED

Benchmarks were tested using a USB 3.0 Type-A connection on a Surface Pro 4 running full Windows 10 Pro 64-bit. The disk speed results were determined using a 2015 version of Crystal Disk Mark 3.0.4 running all sequential, 512B and 4KB benchmarks through five test instances of 1,000MB of data. The only exception to this is if the drive was formatted for use with Mac OS, in which case we ran BlackMagic Diskspeed Test to find sequential read and write speeds on a 2014 13-inch MacBook Air.

A LOOK AT THE SOFTWARE

Most external storage devices you'll buy today come bundled with some kind of software, be it backup software, remote access, encryption or drive utilities. If you're going to buy an external drive, it's absolutely worth knowing what you're going to get on the software front. It can make all the difference.

Typically, drive makers have a standard bundle that they provide with most, if not all, of their external products. Over the next two pages, we thought we'd go ahead and give you an overview of what those bundles are, broken down by vendor.

ADATA software suite

Simple and capable.

ADATA has a licensing agreement with NTI, providing copies of NTI Backup Now EZ 3 and MiST with many of its portable drives.

NTI Backup Now EZ may look a little retro, but it's quite a capable backup tool, offering more options than many of its competitors (including Seagate and Western Digital) at the cost of increased complexity. It supports full system backups, as well as custom backups and it uses scheduled backups rather than continuous. It's a step up from Windows backup, but we still favour Seagate's elegant solution.

NTI MiST is an interesting option for many users. It works rather like ownCloud or Seafile: you can create your own cloud server on your PC. Using the mobile apps, your tablets and smartphone can access the media you place on that server. It's kind of like your own personal Dropbox.

Verdict

Despite looking a bit retro and lacking some of the complexity found elsewhere, ADATA provides a capable set of software.

★★★☆☆

LaCie software suite

Solid and user-friendly.

LaCie drives come with a first-rate software suite, including a unique setup application that will initialise the drive for your platform. It will, by default, create a common shared section of the drive in FAT32 and an optionally encrypted partition, formatted for your OS where the bulk of the data will be stored.

After the drive is initialised, the setup application will install LaCie Backup Assistant/Genie Timeline Free, an absolutely solid backup system with continuous backup. It's very easy to use and definitely an improvement on Windows backup, although a lot of configuration options are annoyingly disabled in the free version you get with the drive. It will also install LaCie Desktop Manager. Finally, LaCie also offers Private-Public (which you may have to visit its site to grab), a capable software encryption tool that requires no installation.

Verdict

An easy-to-use, solid backup system. However, an abundance of useful configuration settings are hidden behind a paywall.

★★★★☆

Seagate software suite

Get this, if you can.

Arguably the best bundled backup solution available right now, Seagate's Dashboard comes with nearly all of its consumer external hard drives. Dashboard provides an easy one-click solution for PC backup, and supports continuous backup as well as full-system backup.

The true strength of the app is in its mobile and social media integration. It can back up your Facebook and Flikr media easily: you just need to give it your password. It also provides a backup service for Seagate mobile backup apps on Android and iOS. Those apps will talk to the Seagate Dashboard app installed on your PC and use it to transfer the data to the Seagate drive attached to the PC.

If a backup solution is important to you, this is definitely the one to get. There are some strong contenders – WD in particular – but this is our current top solution.

Verdict

Best-in-class backup software around with powerful continuous backup for your PC and online social world.

★★★★½

Samsung's only tool is the drive decryptor, which is available on PC and Android.

Samsung

★★★★★

Samsung's portable SSDs typically don't come with any backup or additional software. What they do come with is a driver and an installable tool for deploying and managing the hardware encryption systems built into the drives. The encryption system is very straightforward, and it's available for Android mobiles as well (so you can use an encrypted Samsing SSD on an Android device).

Verbatim provides a DVD burning app, as well as backup.

Verbatim

★★★½

Verbatim drives usually come with Nero's BackItUp and Burn Essentials, a cut-down bundling of Nero's full backup tool and CD-ROM burning application. It doesn't seem to have been updated in some time, but it's still a capable tool. It has an easy backup option, but also has more fine tuning options than you'll find in Seagate and WD's tools. It's fairly rough overall, but still a better bet than Windows 10's flaky integrated backup tool. Of course, most things are.

apc HOT PRODUCT

Toshiba software suite

Great feature set.

With Toshiba, the availability of bundled software depends on whether you purchase the Connect/Premium model or the Basics model. Canvio Basics drives do not come with additional software. They're just provided as-is.

Canvio Connect drives, however, come with an interesting suite of tools. For backup, they provide NTI Backup Now EZ, the same tool provided with ADATA drives (see back over the page). It's not as sleek as the WD and Seagate solutions, but it's still a serviceable solution (and better than nothing).

Perhaps the more valuable inclusion, however, is the fully-licensed Pogoplug Remote Access software that lets you access the contents of the drive over the internet. It's easy to use and works really well, a major selling point for Toshiba. Canvio Connect drives also frequently come with a limited cloud backup and storage subscription.

Verdict

A great software backup suite that may lack the polish of some of the competition but none of the capabilities.

★★★★½

apc RECOMMENDS

Western Digital software suite

Simple, but not lacking.

Nearly all Western Digital drives come with WD SmartWare as an option, and many drives (including the desktop drives) come with a licence for a special edition of Acronis True Image as well.

WD SmartWare is an excellent, consumer-friendly backup solution, on par with Seagate's solution for PC backup but lacking its mobile and social media support. It provides a super-simple one-click option as well as a customed backup. Backup is continuous or scheduled, and the app provides plenty of storage imagery, showing you how much space is being used by what kind of data.

Acronis True Image (a drive imaging tool) is available on many drives, too. It's an outstanding solution for a full system backup and system migration. It offers incremental and continuous updates, ensuring that the backup drive image always matches the actual PC.

Verdict

WD SmartWare and Acronis True Image provide a user-friendly and great backup solution.

★★★★

$319.95
WWW.G-TECHNOLOGY.COM

G-Drive ev ATC 1TB

The Mac user's impervious storage unit.

The ev ATC range is the fastest 'rugged' drive we've ever seen. When you look at the sequential read speeds, it's even at the heels of the fastest single portable drive we've tested. G-Drive's current range is aimed at Mac users; the drives don't even register on Windows Devices straight out of the box. The ev ATC has a unique design with the main hard drive being ensconced by a removable waterproof casing that includes an inbuilt thunderbolt casing, allowing you to transfer files without having to remove it. Punching out sequential read and write speeds of 137MB/s and 130MB/s, respectively, and coming with a USB 3.0 cable, this speedy drive is hard to fault in any way.

Verdict

Fast and airtight — a winning combination, if you can afford it.

★★★☆☆

$190
WWW.G-TECHNOLOGY.COM

G-Drive Mobile USB-C Drive 1TB

Fast but not great.

The G-Drive USB-C mobile drive from G-Technology has a little more to boast about than some of the company's other offerings, but it's still worth prefacing that the USB-C standard doesn't offer improved transfer rates over and above USB 3.0. That said, the G-Drive Mobile USB-C Drive is packing a fast 7,200rpm disk drive that pushes sequential transfer rates to 135MB/s when reading and 128MB/s while writing. The G-Drives are formatted specifically for Mac, so for PCs, you will have to manually format the drive before you can use it. It is better than the Mobile USB/ Firewire model but it's far from being good value in terms of available hard drives.

Verdict

Another overpriced drive from G-Drive.

★★★☆☆

$150
WWW.G-TECHNOLOGY.COM

G-Drive Mobile USB/ Firewire 1TB

Can this drive handle the Gs?

Slightly chunkier than your average ultra-slim drive, the G-Drive isn't going to be breaking any records for how compact it is and considering it weighs in at 283g, it's also notably heavier than the other drives we tested. The G-Drive Mobile USB is one of the only portable drives we've seen with two firewires and a USB output, so even though it is encased in a stock-standard metal enclosure, it does have at least one unique feature. Unfortunately, the 5,400rpm disk drive is a little slower than what we're used to, with sequential read and write speeds at around 105MB/s and 102MB/s, some 20%–30% slower than your standard 7,200rpm-equipped portable drives.

Verdict

Pricy, cumbersome and unfortunately, a little slow.

★★☆☆☆

$399
WWW.LACIE.COM

LaCie Porsche Design Mobile Drive 4TB

C into the future.

Being one of the only portable drives here with the option of USB Type-C to C transfers and the only hard drive to be designed by a sports car manufacturer, we were expecting the Porsche Design Mobile Drive from LaCie to be a speedy little device. Despite it being the fastest single portable hard drive we've tested, transfer rates are still leagues away from actually needing the new USB 3.1 protocol. At 137MB/s and 134MB/s sequential read and write speeds, Porsche Design Mobile Drive is between two and three times slower than the speediest flash drives. When you put it up against Seagate's $160 2TB Backup Plus Ultra Slim drive, it's less than 5% faster overall.

Verdict

An expensive drive that could be twice as fast for the price.

★★½☆☆

$390
WWW.SEAGATE.COM

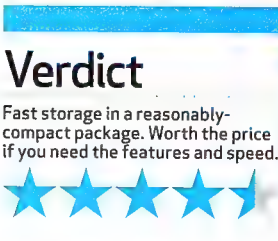
Seagate Backup Plus Fast 4TB

A compelling but pricey option.

Not to be confused with Seagate's standard 4TB portable drive, this chunky model is heavier and larger than most on the market. But there's actually two 2TB drives inside in a RAID configuration, which means it's also very fast (up to 250MB/s) – that's provided, of course, you've got a USB 3.0 connection and you're copying to or from a similarly speedy drive, like an internal SSD. There's a two-headed Y-cable in the box, which you'll need to use for connecting to USB 2.0 ports. Seagate's Dashboard software is included, one of the most comprehensive backup apps on offer. Of course, higher-end features cost moolah, so this one's not cheap. You do get what you pay for, though.

Verdict

Fast storage in a reasonably-compact package. Worth the price if you need the features and speed.



$156
WWW.SEAGATE.COM/AU

Seagate Backup Plus Ultra Slim 2TB

Teeing off with an even slimmer drive.

Seagate decided that a shiny metallic gold or silver topside with a golf ball pattern was the key to its latest Backup Plus Ultra Slim drives, hoping the lunar-like surface will accentuate the 3mm reduction in width from the existing range. But more noticeable is the drive's slight boost in read and write speeds when compared with the Backup Plus Slim. The Backup Plus Ultra Slim showed 15MB per second boosts for sequential read and write speeds on the Backup Plus Slim models, which roughly corresponds to the 10% price difference. The cost per GB is reasonable on this drive and the weight and size live up to its title.

Verdict

A well-priced hard drive which is slim on every front... except its name.

$170
WWW.SEAGATE.COM

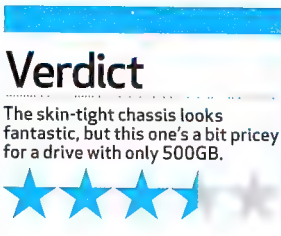
Seagate Seven 500GB

It's what's on the inside that counts.

The standard portable hard drive package tends to be somewhere between 10 and 15cm long, 8cm wide and 1.5cm thick. Even the Seagate Seven can't do much to change the horizontal parameters of a spinning disc and, as such, the first two dimensions are the same, but by stripping out any erroneous casing, it's managed to come in at only 0.7cm thick. The Seven's read and write speeds are similar to other compatible portable drives in this roundup, but this elasticated drive has come down in price since its launch and you can actually get it on sale for up to $70 cheaper than the retail price. If you can get it on sale, it's a nice looking and exceptionally portable drive.

Verdict

The skin-tight chassis looks fantastic, but this one's a bit pricey for a drive with only 500GB.



1TB, $90; 2TB, $140
MYTOSHIBA.COM.AU

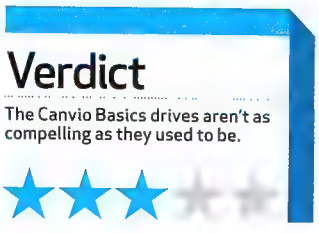
Toshiba Canvio Basics 2TB

A bare-essentials option.

For the last few years, Toshiba's Canvio Basics drives have been excellent-value options, with this family of models often selling for $10–$20 below the equivalent WD and Seagate units. That margin has narrowed to almost nothing in recent months, however, and poor availability does dull the appeal. The name ('Basics') denotes something important – there's no software included (backup or otherwise), so you'll need to sort out your own, like SyncBack Free. You'll also need to reformat it if you want to use it on a Mac. Performance was largely average with transfer speeds of around 116MB/s for reads and 114MB/s when writing.

Verdict

The Canvio Basics drives aren't as compelling as they used to be.



1TB, $88; 2TB, $136
WWW.MYTOSHIBA.COM.AU

Toshiba Canvio Connect II 1TB

Stuck in the middle.

Though the marketing spiel for the Canvio Connect will have you thinking the drive has some kind of wireless data transfer capability, it's nothing more than the bundled software that allows for the remote access of files and even then it's not remote access of files stored on the portable drive. The drive itself is reasonably commonplace in other ways, with the usual 10.9cm, 7.8cm and 1.4cm dimensions and 150g weight. The tested speeds also stick closely to what we expected, with 116MB/s sequential read and write speeds with a similarly unsurprising small file read and writes speeds of 41MB/s and 49MB/s. There weren't any downsides, well other than being a little dull.

Verdict

A reasonably-priced portable that safely sits in the middle of the pack.

★★★½☆

$90
MYTOSHIBA.COM.AU

Toshiba Canvio Slim II 1TB

An average performer.

A brushed-aluminium chassis, compact design and low 150g weight make this nice to look at and hold. It's even a tad smaller than WD's My Passport Ultra design. Unlike the Canvio Basics line, you get some software – both encryption and backup are handled with third-party tools and Toshiba has also bundled in an NTFS driver for Macs, so you can use this drive without reformating it. We've noticed some online retailers discounting this 1TB model to as low as $70 and, at that price, it's a bit of a steal. We're presuming this particular line's nearly at the end of its shelf-life, with fewer retailers stocking it; if you want to pick one up, you'd better get a wriggle on.

Verdict

Pleasing design and generally good software offering make this an appealing option.

★★★½☆

2TB, $400; 4TB, $550
WWW.WDC.COM

WD My Passport Pro 2TB

A lightning-fast dual-drive model.

With the arrival of portable SSDs that can reach over 450MB/s write speeds, dual hard disk portable drives are going to have a hard time if they want to remain competitive. This model uses a thunderbolt connection and a dual drive in RAID 0 configuration to read and write speeds over the 200MB/s mark, around double the speeds of a hard disk drive. The use of thunderbolt and a the HFS+J disk format peg this drive as one specifically for Mac users. $400 is a lot for a portable drive, but at the moment, it still hits a unique price, speed and capacity point when you consider, for the same money, you could only afford a 512GB portable SSD.

Verdict

Lives up to its promises, but is less versatile than Seagate's similar Backup Plus Fast.

★★★½☆

500GB, $89; 1TB, $100; 2TB, $160; 3TB, $285 | WWW.WDC.COM

WD My Passport Ultra 3TB

Reasonably priced, good at the basics.

The My Passport Ultra is WDigital's ultra portable offering at 150g – the second lightest we've tested. Apart from introducing a 'New' upgraded model that boosted speed slightly, this drive hasn't changed much. It's reasonably priced with the 500GB model going for $89, though you can get the 1TB Canvio Connect II from Toshiba for the same price. The hardware here is top notch, with an attractive external design, hardware-based 256-bit AES encryption and the software suite is a good package. The new My Passport Ultras nett respectable sequential read and write speeds of 124.5 and 123MB/s, respectively, and the wide range of available colours are sure to suit anyone.

Verdict

An surprisingly affordable premium drive with good hardware and software.

★★★★☆

"Benchmarks were tested using a USB 3.0 Type-A connection on a Surface Pro 4 running full Windows 10 Pro 64-bit. The disk speed results were determined using a 2015 version of Crystal Disk Mark 3.0.4 running all sequential, 512KB and 4KB benchmarks through five test instances of 1,000MB of data."

PORTABLE HARD DRIVE TEST RESULTS

PRODUCT NAME	SUSTAINED READ SPEED (MB/S)	SUSTAINED WRITE SPEED (MB/S)	SMALL FILES READ SPEED (MB/S)	SMALL FILES WRITE SPEED (MB/S)	COST PER GB
G-DRIVE EV ATC (1T) *	136.1	130.4	N/A	N/A	$0.320
G-DRIVE MOBILE USB-C (1T) *	135.4	128	N/A	N/A	$0.190
G-DRIVE MOBILE USB / FIREWIRE (1T) *	104.7	102.3	N/A	N/A	$0.150
LACIE PORCHE DESIGN MOBILE DRIVE (4TB)	137.7	134	45.21	98.53	$0.0975
SEAGATE SEVEN (500GB)	120.9	118.9	41.35	37.33	$0.340
SEAGATE BACKUP PLUS ULTRA SLIM (2T)	129	128.2	44.69	87.73	$0.078
SEAGATE BACKUP PLUS FAST (4TB)	250.4	249.5	42.78	88.85	$0.097
TOSHIBA CANVIO BASICS (2TB)	116.4	114.2	42.21	47.27	$0.065
TOSHIBA CANVIO SLIM II (1TB)	111.8	111	42	48.52	$0.130
TOSHIBA CANVIO CONNECT II (1TB)	115.9	115.5	41.15	49.32	$0.088
WD MY PASSPORT PRO (2TB)*	206	210	N/A	N/A	$0.200
WD MY PASSPORT ULTRA (3TB)	124.5	123	45.2	79.2	$0.094

* TESTED ON MAC WITH BLACKMAGIC DISK SPEED TEST

PORTABLE HARD DRIVES SPECIFICATIONS

MODEL	SIZE OF TEST DRIVE	PRICE	AVAILABLE SIZES	DIMENSIONS (LXWXH, CM)	WEIGHT (G)	CONNECTIVITY
G-DRIVE EV ATC	1TB	$320	1TB	20.4 x 5.4 x 5.21	372	THUNDERBOLT, USB3.0
G-DRIVE MOBILE USB-C	1TB	$190	1TB	12.9 x 8.2 x 1.3	174	USB 3.0 & 3.1
G-DRIVE MOBILE USB / FIREWIRE	1TB	$150	500GB, 1TB	12.7 x 8.3 x 1.8	177	USB 3.0, FIREWIRE
LA CIE PORCHE DESIGN MOBILE DRIVE	4TB	$399	2TB, 4TB	13 x 7.7 x 1.5	315	USB 3.0 & 3.1
SEAGATE SEVEN	500GB	$170	500GB	12.2 x 8.2 x 0.7	178	MICRO + USB 3.0
SEAGATE BACKUP PLUS ULTRA SLIM	2TB	$156	1TB, 2TB	11.3 x 7.6 x 0.96	159	MICRO + USB 3.0
SEAGATE BACKUP PLUS FAST	4TB	$390	4TB	11.7 x 8.3 x 2.2	307	MICRO + USB 3.0
TOSHIBA CANVIO BASICS	2TB	$125	500GB, 1TB, 2TB	11.9 x 7.9 x 1.5	210	MICRO + USB 3.0
TOSHIBA CANVIO SLIM II	1TB	$129	1TB	10.7 x 7.6 x 1.3	150	MICRO + USB 3.0
TOSHIBA CANVIO CONNECT II	1TB	$88	500GB, 1TB, 2TB, 2.5TB, 3TB	10.9, 7.8, 1.4	149	MICRO + USB 3.0
WD MY PASSPORT PRO	2TB	$400	2TB, 4TB	14.3 x 8.9 x 2.8	450	THUNDERBOLT
WD MY PASSPORT ULTRA	3TB	$199	500GB, 1TB, 2TB, 3TB	11 x 8.1 x 1.5	150	MICRO + USB 3.0

"Some desktop drives actually include multiple hard drives, arranged for super capacity or in a RAID format for additional reliability."

Going big: desktop external hard drives

Sometimes, capacity is more important than portability

Although most of the market is in portables, desktop external hard drives still have a place in many homes and businesses. If you work with a lot of data, if you have a huge media library to back up, or if you need to back up a NAS or multiple systems, then a desktop external hard drive may be the way to go.

Desktop externals typically use full-size 3.5-inch hard drives, each drive offering capacity of up to 8TB and more, most recently 10TB. Some desktop drives actually include multiple hard drives, arranged for super capacity or in a RAID format for additional reliability.

The downside is that they're both heavy and usually require mains power in use. USB simply doesn't provide enough juice to support them. There are exceptions, of course. With new USB standards providing more power, there are products like Seagate's Innov8 that can run fully on USB without an external power source. But these are rare for now.

Below, we've looked at a selection of current desktop hard drives as well as some of the enclosures that you can use to build your own.

HOW WE TESTED

The drives reviewed here were all tested with CrystalDiskMark 5.1.2 on an ASUS ROG G752 laptop. The benchmark gives four major results.

Sequential read and sequential write (in Q32T1). These are an indication of how well the drive handles big files. It's a good gauge of how well the drive will serve for backup.

4K read and 4K write (in Q32T1). These indicate how well the drive handles writing a huge number of tiny (4KB) files in quick succession. This gives a better indication of how well (comparatively speaking) the drive will perform in heavy general usage.

Although CrystalDiskMark provides multiple results for each of these, we'll focus on the Q32T1 results, which are more relevant for real-world usage. With Q32T1, the benchmark provides a queue of files rather than delivering them one at a time. This lets the drive's caching and reordering smarts factor into the test results (which they would in real-world usage).

Capacity: 8TB; **Connectivity:** USB 3.1 Type-C

$569 | WWW.LACIE.COM

LaCie Porsche Desktop Drive 8TB

Worth the price?

LaCie is one of the few drive vendors that goes to great lengths to make its product look unique. Unfortunately, the Porsche Design is a rare miss for the company. What does stand out is its performance and features.

The LaCie supports USB 3.1 with a Type-C connector, and comes with both a Type-A to Type-C and Type-C cable. It also has US and UK power adapters.

Tested with USB Type-C, the LaCie performed incredibly well in the sequential read test, topping 200MB/s read speeds. It didn't do quite as well in the write results or the 4K results, although its performance in both was still perfectly solid compared to the competition.

Given those results, and the capable software provided by LaCie, this is definitely a top drive. The hefty price tag may be a big turn-off, however – at over $500, the P9237 should at least come with the licensed versions of Genie backup!

Verdict

Great performance and good software, but youch on the price.

★★★½☆

Capacity: 8TB; **Connectivity:** USB 3.1 Type-C

$499 | WWW.SEAGATE.COM

Seagate Innov8 8TB

Powered by USB.

The Innov8 has one thing that none of it competitors can boast: it's powered entirely by USB. It requires no mains power, instead using the additional power draw offered by USB 3.1 and a unique 'ignition' startup system.

The consequence of this, however, is that you must have a computer with USB Type-C for it to be useful. It doesn't even come with a Type-A adaptor or external power option.

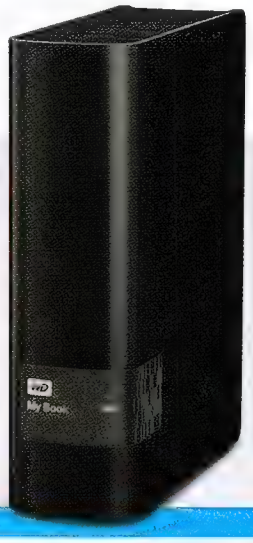
The performance of the drive, like that of the LaCie, was excellent. If you want sequential read speeds approaching some SSDs, this will get you there. The drive comes with Seagate Dashboard, the excellent backup solution that Seagate provides with most of its external products. We actually had problems installing it from the drive (it would launch and then immediately close on our test system), but we just went to Seagate's site and installed it from there without any further hassle.

Verdict

It's still heavy, but it sure is nice not to need mains power. USB Type-C is required, however.

★★★★½

Capacity: 4TB; **Connectivity:** USB 3.0



$229 | WWW.WDC.COM

Western Digital My Book 4TB

A mid-range solution.

WD's My Book design hasn't changed much over the years. The drives are made to be stacked side by side (like books, hence the name), and the design reflects that.

Unlike Seagate and LaCie, WD has not moved up to USB 3.1 and Type-C. The My Book (like the Duo and Duo Pro over the page) still uses the older 3.0 standard. It did seem to make a notable difference in our tests, but the slower speeds could also be a reflection of the older 4TB hard drive inside the My Book we tested. The drive comes with both SmartWare and the outstanding Acronis True Image, and so makes a perfect solution for migrating from one system to another or for keeping a full backup of every file, including program and OS files.

If you don't need the capacity of the other monsters reviewed here, and don't have or care about USB 3.1, then the WD My Book still gets the job done. It's an older product, but it checks out.

Verdict

A great solution for older systems with fewer storage needs.

★★★½☆

A RAID re-primer

Like many NASs, a number of desktop external drives support multiple drives configured in RAID. RAID unites multiple physical drives into a single volume that will look like a single drive to your computer. There are different flavours of RAID, and which you'll choose will depend on your priorities: performance, capacity or reliability.

RAID 0

Also known as striping, RAID 0 gives maximum performance. Files are spread across multiple drives increasing speed. However, if any drive dies, all the data wil be lost.

RAID 1

This mirrors the drives. Whatever is written to one is written to all. That means that, if any drive dies, the others still have all the data. You sacrifice capacity, however. If you have a two-drive array, you'd lose half your capacity.

RAID 5

RAID 5 distributes parity information across drives that allows data to be reconstructed in the event of one of the drives failing. The cost is the capacity of one drive (for example, four 4TB drives would create a 12TB array) and a modest hit on write performance. JBOD just joins the drives into a single volume, offering no performance or reliability advantages. You'd use JBOD in situations where you have asymmetric drives (say a 1TB drive and a 4TB drive), and you want to get the full capacity.

Capacity: 12TB; **Connectivity:** USB 3.0 (two USB 3.0 host ports as well)

$869 | WWW.WDC.COM

WD My Book Duo 12TB

Capacity and reliability.

The My Book Duo contains two hard drives. On our tested device, those were two 6TB capacity drives, for a total of 12TB. Those hard drives are WD Red HDDs, specifically designed for heavy workload server applications.

The drives can be arranged in RAID 0 (default) or in RAID 1, which halves the capacity (to 6TB), but ensures data reliability. The My Book Duo also boasts twin USB 3.0 host ports. If you're facing a shortage or USB ports, this could be just what you need. Tested in RAID 0, the performance of the drive was good, but short of the read speeds of the Seagate and LaCie USB 3.1 drives. Oddly, its write speed was much higher, perhaps because of the enterprise-class drives being used.

Given the high performance, as well the hardware encryption and very good software (the drive comes with the 'Pro' version of SmartWare, as well as Acronis True Image), this is a top pick. You know, if you can afford it.

Verdict

Great capacity and performance, but a very high price. At that cost, you might be better off with a NAS.

★★★★☆

Capacity: 8TB; **Connectivity:** Thunderbolt 2 and USB 3.0

$1,099 | WWW.WDC.COM

WD My Book Pro 8TB

Super speedy. Super expensive.

This looks an awful lot like a NAS. It uses WD Black drives, with a combined capacity of up to 16TB (we tested 8TB). The My Book Pro is targeted primarily at Mac users, having twin Thunderbolt 2 ports in addition to USB 3.0 and coming formatted for Mac OS.

Windows users, however, can reformat the drive, which is what we did (to NTFS). It performed incredibly well, blasting the competition even over USB 3.0. The sequential read and write speeds hit roughly 300MB/s! It did not perform nearly as well in the 4K tests, however, with some surprisingly low results. As with the Duo, the drives can be arranged in RAID 0, RAID 1 or JBOD configuration. There are additional USB 3.0 ports for chaining additional devices.

Because it's built for Mac, it doesn't come with WD SmartWare on the drive – in fact, the only utility you get is the WD Drive Utilities, used for selecting RAID and formatting the drive.

Verdict

It's incredibly fast, but oh so pricey. We'd strongly consider a NAS at this price.

★★★½☆

Standalone hard drive enclosures

Packaged USB hard drives aren't the only solution.

A number of companies also offer DIY enclosures. These are external drive cases without the drive installed – so you'll need to grab a hard drive of your own to install. They will generally take standard-sized internal hard drives: 3.5" for the desktop solutions (like those below) and 2.5" for portable solutions. Obviously, the performance you get from the enclosure will depend on what drive you put into it and the interface used by the enclosure. If you're buying a new enclosure, make sure that it supports at least USB 3.0.

Enclosures are particularly useful for resurrecting old hard drives and turning them into additional backup targets. If you have an older PC that you were otherwise going to recycle, it's worth taking a couple of minutes to rip out the hard drive. Not only does this prevent your data from potentially falling into other people's hands, you can put it in a $30 or $40 enclosure and have yourself a whole new external hard drive to back up on.

As you might expect, enclosures are available in a variety of flavours and with different connectivity options. There are single-drive enclosures that take either a 2.5" or 3.5" hard drive (if you have a hard drive already, make sure you get the right size enclosure), but there are also multi-drive enclosures that allow you to insert several drives and combine them into RAID volumes. We've looked at a sample of each type. Read on

Drives: 1; **Connectivity:** USB 3.0

$32 | WWW.ENCOMTECH.COM.AU

BlueEye BE35611

A cheap and easy one-drive solution.

Enclosures don't come much simpler than the BlueEye BE35611, a single drive, USB 3.0 solution that comes with no frills or extras: just a case, mounting brackets, a USB cable, power supply and the world's cutest Philips head screwdriver in the box.

Mounting a drive in the BlueEye requires no additional tools. Just two screws need to be removed from the rear, the drive slid into place with the mounting brackets and the rear panel screwed back on. The drive comes with no instructions on how to do this, but it's not at all difficult to figure out.

We put a 4TB Hitachi drive in the BlueEye and tested it using the same method as the packaged external hard drives. The results were decent, with a sequential write speed of just over 110MB/s and a sequential read speed of 82.6MB/s. Not bad for a cheap solution with an older drive installed. If you have a drive from an old PC, this is the perfect solution to give it new life.

Verdict

Cheap and simple.

★★★½☆

Drives: 5; **Connectivity:** USB Type-C

$365 | WWW.TERRA-MASTER.COM

TerraMaster D5-300

Five drives. Count 'em.

The TerraMaster is a five-drive monstrosity, looking very much like a NAS but having none of the network connectivity or service support. Instead it talks to the computer through a single Type-C USB port.

It supports capacities of up to 40TB. Using the RAID Manager (download from **www.terra-master.com**), drives can be arranged in RAID 0, 1, 3, 5 or JBOD.

Built of aluminium, the D5-300 is remarkably light without any drives installed. Installing the drives can be a little painful: you have to screw the drives onto trays and slide them in. But once they're installed, you'll likely have an external hard drive that's the envy of everyone. We tested it with two 4TB Hitachi drives, arranged in RAID 0, and it hit a nice 168MB/s sequential read and 145MB/s sequential write, fast enough for most applications.

Again, while a NAS won't offer the same level of direct read/write speeds, it'll be a lot more versatile.

Verdict

A five-drive array is impressive, but a NAS might be better if you're willing to pay this amount of money.

★★★☆☆

DESKTOP EXTERNAL HARD DRIVES SPECIFICATIONS & TEST RESULTS

PRODUCT	LACIE PORSCHE DESIGN	SEAGATE INNOV8	WESTERN DIGITAL MY BOOK	WESTERN DIGITAL MY BOOK DUO	WESTERN DIGITAL MY BOOK PRO
PRICE	$569	$499	$229	$869	$1,099
WEBSITE	LACIE.COM	SEAGATE.COM	WDC.COM	WDC.COM	WDC.COM
SPECIFICATIONS					
CAPACITY (TESTED)	8TB	8TB	4TB	12TB	8TB
USB	3.1, TYPE-C	3.1, TYPE-C	USB 3.0	USB 3.0	TWO THUNDERBOLT 2 AND USB 3.0
WEIGHT	870G	1.5KG	1.03KG	2.31KG	3.57KG
SOFTWARE	LACIE DRIVE MANAGER	SEAGATE DASHBOARD	WD SMARTWARE	WD SMARTWARE PRO	WD DRIVE UTILITY
	GENIE TIMELINE FREE		ACRONIS TRUE IMAGE	ACRONIS TRUE IMAGE	
TEST RESULTS: CRYSTALDISKMARK 5.1.2					
SEQUENTIAL READ Q32T1 (MB/S)	201.1	184.5	115.6	174.6	275.7
4K READ Q32T1 (MB/S)	2.061	1.994	1.565	0.62	0.627
SEQUENTIAL READ	199.4	202.8	111.3	176.2	335.6
4K READ	0.539	0.514	0.445	0.569	0.584
SEQUENTIAL WRITE Q32T1 (MB/S)	56.99	61.9	55.8	162.4	275.4
4K WRITE Q32T1 (MB/S)	3.648	3.451	3.012	1.234	0.5
SEQUENTIAL WRITE	28.31	30.2	29.4	164.8	325.1
4K WRITE	0.166	0.166	0.116	1.25	0.498

Wireless hard drives

Nathan Taylor tests a batch of portable NAS drives.

Although they've never really set the world on fire, for a certain kind of user, wireless drives make great travelling and home companions. They're a perfect way to carry a lot of data on the road with you when you're only bringing along a mobile or tablet, and they often do double duty as a relatively inexpensive NAS for serving media to devices around the home.

For those unfamiliar with them, a wireless drive is an external USB hard drive or flash drive with an integral Wi-Fi antenna. They often also have integral battery packs so they can be used when not connected to a power source. The Wi-Fi antenna is used to create a hotspot; any devices connecting to that hotspot can access the contents of the drive, either through a mobile app or standard file protocols like SMB or DLNA.

That effectively turns the drive into a kind of limited mini-NAS that you can take with you when you travel. You can access its contents from your mobile or your laptop, share media and files with people you meet just by giving them a password, and even, in some cases, directly download or backup data from your mobiles and cameras.

HOW WE TESTED

For wireless drives, we performed a simple read and write copy test from a PC with an attached D-Link 867Mbps 802.11ac Wi-Fi adapter. Tests were performed at a range of 5m.

A single file of 500MB was copied to and then from the device and the transfer speed recorded, in megabytes per second.

Capacity: N/A; **Wireless:** 802.11ac; **Services:** SMB, DLNA; **Power:** battery, 11 hours

$76 | WWW.KINGSTON.COM

Kingston MobileLite Wireless G3

A jack of all trades.

Kingston's MobileLite G3 is an interesting beast. Unlike the other devices here, it has no integral storage. Instead, it uses storage connected to its USB 2.0 host port and SD card port. That means it has as much 'capacity' as you're willing to plug into it. (For people who do want some capacity baseline, there is a Pro version of the product with 64GB of flash storage).

The USB 2.0 host port can deliver up to 2A of power, so most portable hard drives will work just fine with the MobileLite. That also makes it a decent charger; it has 5,400mAh of power in its own battery bank and is charged via micro USB.

In addition, there's a wired Fast Ethernet port, the latter allowing the Kingston to bridge to a wired network and be an access point. Even if you're not connected to a wired network, there's an optional wireless bridge mode that lets the Kingston access a separate wireless network as a client, so you can access the Kingston's content and the internet at the same time.

The mobile apps are fast and functional, with simple backup and file access, as well as an integral media player. If a media format is not supported, it can launch a third-party app.

Although we think the physical design has actually regressed a little since the G2, the versatility and functionality is pretty fantastic. You can easily attach portable drives to it, and its ability to serve as an 802.11ac access point, wired bridge, file and media server as well as mobile charger provides a lot of value. A USB 3.0 host port would have been nice, but it's still a great buy.

Verdict

Although you have to provide your own storage, the versatility of the G3 makes it a great option.

★★★★☆

Capacity: 1TB; **Wireless:** 802.11ac; **Services:** DLNA, SMB; **Power:** USB (no battery)

$369 | WWW.LENOVO.COM.AU

Lenovo ThinkPad Stack Wireless Router/1TB Drive

For neat freaks.

Lenovo's ThinkPad Stack is a neat and attractive suite of common computer accessories, sold separately or in bundles, including a router, external 1TB hard drive, Bluetooth speaker and 10,000mAh power bank. The components magnetically stack on top of each other.

The router/access point and external hard drive make an effective wireless drive, accessible via SMB or DLNA or the Thinkpad Stack Assistant mobile app. Lenovo sells them together, for the hefty price of $370.

For that price, you're not really getting all that much. The router is very limited, the most basic type of 802.11ac access point with a single Fast Ethernet port for bridging to an existing network or WAN access. At least it does have USB 3.0 connectivity, as well as a USB host port that supports 3G/LTE adapters.

During testing, it delivered read speeds just shy of 13MB/s, which was better than most 802.11n devices but inferior to the Western Digital (over the page) by a considerable margin. On the other hand, the drive did well when we connected it directly to a PC via USB, delivering transfer speeds just over 90MB/s.

Neither the router nor hard drive have an internal battery, so you'll need to connect an external USB power source.

Given all the costs and the limitations, the ThinkPad Stack makes a poor wireless drive option. It may be appealing if you're interested in the ThinkPad Stack bundle – it certainly looks cool when all the devices are stacked together – but if you're just looking for a wireless drive, this is a definite miss.

Verdict

Way too expensive, especially for a product with a limited mobile app and weak feature set.

★★½☆☆☆

Capacity: 64GB; **Wireless:** 802.11n; **Services:** mobile app and web only; **Power:** battery, 4.5 hours

$70 | WWW.SANDISK.COM.AU

SanDisk Connect Wireless Stick 64GB

A thumb drive with Wi-Fi.

If portability is your number-one priority in a wireless drive, then you won't be able to do better than SanDisk's Connect Wireless Stick. Available in versions up to 200GB (we looked at the 64GB version), the SanDisk Connect looks much like a fat thumb drive and weighs just 22g.

As small as it is, the wireless stick still has an internal battery, capable of 4.5 hours of independent usage and recharged when you plug it into a USB port.

As you might expect, the specs on the Wireless Stick are not exactly top of the line. Only single band 802.11n is supported and it's limited to 150Mbps. The USB is 2.0, so USB file transfers are practically limited to about 30MB/s (and were just 15MB/s when we tested it).

Its application support is also limited. It does not have any integral DLNA or SMB support. Instead, if you want to access its contents over Wi-Fi, you'll have to use the SanDisk Connect Drive app on Android and iOS or a Web browser on PC.

The SanDisk Connect Drive app is perfectly solid. You can stream media with it and back up your mobile. On Android, it can launch other apps, including document readers for native viewing of any type of file.

If you don't mind being limited to just the mobile apps, the SanDisk Connect Stick is pretty great. Plug it in to your PC, copy your media files, Launch the app on your mobile and play. It's nice and simple.

However, if you want performance, or if you want general access via Windows File Sharing or DLNA, you'll want to look elsewhere.

Verdict

A marvel of miniaturisation. Just don't expect too much.

★★★½☆

Capacity: 500GB; **Wireless:** 802.11n; **Services:** DLNA, SMB; **Power:** battery, six hours

$80 | WWW.SEAGATE.COM

Seagate Wireless 500GB

Sometimes, a simple design works.

Available in five colours, the Seagate Wireless is a more limited version of the older Wireless Plus, offering less capacity and power but also coming in at a much lower price. But it uses the same software platform.

The model we tested came with just 500GB of storage, which limits its use as a permanent NAS device. It's also bulkier than it needs to be, with a 13cm x 13cm face making it larger than much of the competition. Even with that bulk, the battery is limited to roughly six hours of use and wireless is 802.11n only with three simultaneous users supported. It does support a concurrent mode that lets it connect as a client to another wireless network, allowing users connected to it to access the internet. (As an aside, we didn't love that the wireless was unsecured by default, but that's easily rectified).

In spite of its hardware limits, there's a lot to like about the Seagate Wireless. Its software platform in particular is excellent, perfect for less technical users. Although it supports SMB, Seagate provides very simple, usable apps for Windows and mobile for accessing and copying content. Files can also be accessed via web browser, and a sync tool on Windows makes keeping the drive contents up to date easy. That 'just install the app and go' makes the Seagate Wireless one of the easiest tools to get up and running.

The performance of the drive was also up to snuff. We had no problems running three HD streams simultaneously, and it essentially maxed out the USB 2.0 connection for direct reads and writes.

Verdict

Supremely affordable and quite capable, perfect for people wanting something simple to set up.

★★★½☆

Capacity: 3TB; **Wireless:** 802.11ac; **Services:** DLNA, SMB; **Power:** battery, 10 hours

$449 | WWW.WDC.COM

Western Digital My Passport Wireless Pro 3TB

For those who want the best.

The WD My Passport Wireless Pro has a handy 3TB of capacity; 802.11ac wireless; an SD-Card reader; a USB 2.0 host port, as well as a USB 3.0 device port; and an integral battery that can drive it for up to 10 hours.

The SD Card reader and the USB 2.0 host port allow you to directly dump content from your mobile, flash drives and camera onto the drive without an intermediary PC. Just plug the card or device in and you can access its contents. As an added bonus, the USB host port can charge mobile devices from the Wireless Pro's 6,400mAh battery.

To connect it to a PC for file transfer, you instead use the Wireless Pro's USB 3.0 device port. For direct transfers, this makes a huge difference: where USB 2.0 devices are pretty much limited to 30–35MB/s, the Wireless Pro hit 83.5MB/s when we tested it with a wired connection. Its use of 802.11ac was also a major performance boon: its wireless transfer speeds were well ahead of the pack. Also, up to eight devices are supported at once.

WD provides a solid suite of apps – nothing fancy, but WD My Cloud lets you access the contents of your drive like it's a cloud service similar to Dropbox. Media is accessible, though if you want general file copy access, you'll have to use an SMB-capable tool like ES File Explorer.

The only real downsides are its weight (nearly half a kilo), as well as what looks to be a hefty price tag. There are two capacities of the Wireless Pro available: the 2TB model will set you back $389, while the bigger 3TB option is $449.

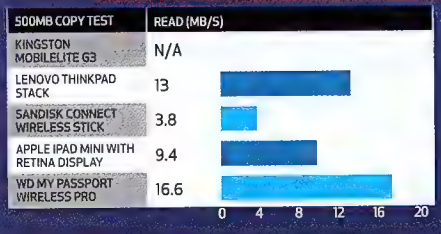
Verdict

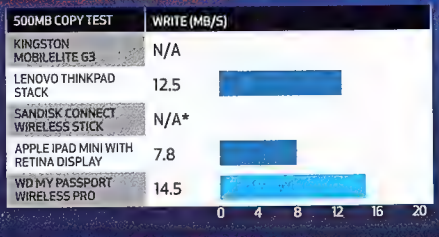
Top of the tech tree, but it will set you back a pretty penny.

★★★★½

"For wireless drives, we performed a simple read and write copy test from a PC with an attached D-Link 867Mbps 802.11ac Wi-Fi adapter. Tests were performed at a range of 5m."

LABS BENCHMARK RESULTS





WIRELESS HARD DRIVES SPECIFICATIONS

PRODUCT	KINGSTON MOBILELITE G3	LENOVO THINKPAD STACK WIRELESS ROUTER/1TB HARD DRIVE KIT	SANDISK CONNECT WIRELESS STICK	SEAGATE WIRELESS	WESTERN DIGITAL MY PASSPORT WIRELESS PRO
PRICE	$76	$370	$70	$90	US$229
WEBSITE	KINGSTON.COM	LENOVO.COM.AU	SANDISK.COM.AU	SEAGATE.COM	WDC.COM
SPECIFICATIONS					
CAPACITY (TESTED)	N/A	1TB	64GB	500MB	3TB
WIRELESS	802.11AC	802.11AC	802.11N	802.11N	802.11AC
WIRED	USB 2.0 HOST PORT, SD-CARD READER, FAST ETHERNET	USB 3.0 HOST PORT AND USB 3.0 DEVICE PORT, FAST ETHERNET	USB 2.0	USB 2.0	USB 3.0 DEVICE, PLUS USB 2.0 AND SD-CARD HOST PORTS
WEIGHT	192G	350G	22G	281G	450G
SERVICES					
DLNA	YES	YES (LIMITED)	NO	YES	YES (PLUS PLEX)
SMB	YES	YES	NO	YES	YES
AIRPLAY	YES	NO	NO	YES	YES
MOBILE APPS	ANDROID, IOS	ANDROID, IOS	ANDROID, IOS	ANDROID, IOS	ANDROID, IOS

*WITHOUT SMB ON THE SANDISK, WE HAD NO WAY TO WRITE WIRELESSLY. WE USED THE WEB DOWNLOAD FOR DOWNLOAD SPEED TEST.

how to

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

Always keep the firmware on your SSDs up to date.

Re-using an old laptop's screen as a second monitor is technically feasible, but the cost and work involved probably aren't worth the effort.

WINDOWS

WELCOME TO THE DAY THE PROCESS DIED

I'm running Windows 8.1 on my PC and, recently, I got a blue screen crash that said CRITICAL_PROCESS_DIED. I understand from the web that I'm supposed to use `sfc /scannow` ***to fix this, but whenever I try, it gives me 'Windows Resource Protection could not perform the requested operation'. Would rolling back to Windows 7 help?***

Simon T

Yes, it would, but only in an 'avoiding the real problem' sort of way, like rolling yourself into a ball and hiding under the doona. The sfc message occurs because you are trying run it from the Windows Recovery Environment, or perhaps a WinPE that you booted from a USB stick or something. You need to tell sfc where your actual Windows installation is, using `sfc /scannow /offbootdir=c:\ /offwindir=c:\windows` .

We're not super optimistic that this will actually resolve your original blue-screen of death though. The fact that you were inclined to try scanning drive C makes me think that you might have recently installed an SSD as your boot volume. If so, check with the manufacturer in case there is a firmware patch available. We seem to recall some Crucial M4 SSDs were causing this error a while back.

Luis Villazon

HARDWARE

FREE SECOND MONITOR?

I have a 15-inch Lenovo laptop with a Core i7 CPU that's pretty decent for games, but the screen is a touch small. It has an HDMI and a VGA port for an external display and I also have a much older 18.4-inch Acer laptop that includes a VGA port. Can I use this laptop as a second screen? I've looked around for a VGA-VGA cable but I can't find one with the right pins. Would an HDMI-VGA cable work?

Andrew McManish

The short answer to your question is 'nope'. The long answer is... it's actually nothing to do with the pins – it's simply that the video ports on laptops are for output only. There's no hardware inside the Acer laptop that's listening to those ports or that can do anything with any video signal you try to send.

There are remote screencasting apps that work over a network connection, but these will be much too laggy to play games on. So is this project dead in the water? Not quite. If you're absolutely sure you won't ever use or sell the Acer, you can hack the screen into a second monitor. There are instructables on this, but it's really just a question of dismantling the LCD panel and connecting it to a driver board flashed with the right firmware for your panel hardware. You can buy these from China for under $100. This is more hassle than buying a 19-inch monitor, and it isn't really cheaper either. But it is more environmentally friendly and there's a sort of nerd-core charm to it as well.

Luis Villazon

LINUX

WHEN IS A FILE NOT A FILE?

I have a PC running Ubuntu Linux. I use this for programming, among other things, and I have several symbolic links set up to various directories in my build folder. One of these links keeps disappearing every night and I think this might be caused

You should always back up your important data — especially before performing a disk file format conversion.

It's important to recognise when old hardware is actually worth upgrading... and when it's not.

"The PC you have now would be okay for playing indie Steam games, but triple-A titles (even quite old ones) are going to chug."

by some command in my cron file. These are set to clear up various junk files each night, using the find command and possibly one of them is catching the symbolic link as well.

But does a symbolic link to a directory count as a file or a directory? In other words, would it be matched by a 'find -type f' command or 'find -type d'?
Len Proudmoor

You can think of them as a special sort of file if you like, but that isn't really terribly helpful. Linux (and Unix before that) doesn't just have files and folders. Symbolic links, named pipes, sockets and device files are all treated differently enough that you can't just assume that whatever works on an ordinary file will work on them.

A case in point is that the find command won't match symbolic links on either '-type f' or '-type d'. You need to use '-type l' if you want to find links. And if you use the '-L' option with find, it will follow the link to the file or directory at the other end instead.
Luis Villazon

HARDWARE
IS MY DATA SAFE?

I have a drive with some really important but quite old data on it (mainly photos). It's a 1TB drive that's nearly full. As it's currently formatted for FAT32, I'd like to convert it to NTFS, but I'm worried about how safe this is. Is there any risk that my data could be corrupted or lost during the conversion process? Are commercial disk utilities more reliable at performing the conversion process?
Amar Basad

You can convert your drive at the command prompt with `convert D: /fs:ntfs`, replacing 'D' with whatever the drive letter of your disk actually is. Any third-party tool will just give you a pretty button to press that calls the same Windows command, so there's no advantage there.

The conversion process is as safe as any other whole-disk operation, which is to say that you should definitely not trust it on data that isn't backed up. But that's a redundant statement, because you shouldn't trust your unbacked-up data with anything, including the simple passage of time. If your drive isn't backed up, buy another 1TB (or bigger) drive immediately.

This can be formatted for NTFS from the get-go, so you can just copy your data over from one to the other and voila, you have converted your filing system. The old drive becomes your backup drive and you can either leave it as FAT32 or run the conversion command on it, as you please (it doesn't actually make a huge difference).
Luis Villazon

HARDWARE
MESSAGE IN A BOTTLENECK

I have a PC that is an Intel Core 2 Quad Q8300 (2.5GHz) with a GeForce GTX 750 Ti and 4GB RAM. It's been sitting in the cupboard under the stairs for a while now, but I'd like to give it a new lease of life by donating it to my nephew so that he can play games on it.

He's only nine, so he doesn't need the fastest machine in the world, but I've just tried installing a few games on it and even Assassin's Creed 3 ***is unplayably slow. Are there any simple, cheap upgrades I can add to overcome the performance bottleneck so he could play*** Skyrim, ***let's say?***
Malcolm Cauldicott

A bottleneck is where one component is holding the others back. Your PC is actually pretty well balanced and, in its day, would have been a decent gaming machine. If it had a Core i5 CPU instead of a Core 2, you probably wouldn't be writing to me. But they use different sockets and, therefore, different motherboards, so this is neither a cheap nor a simple upgrade. The PC you have now would be okay for playing indie Steam games, but triple-A titles (even quite old ones) are going to chug.

Upgrading the PC with a new motherboard and CPU will cost you $300–400. There are current-gen Core i5 bundles available that include CPU, motherboard and RAM in that price range. That will technically fulfil the contract to your nephew, but you'll also be responsible for performing the upgrade and supporting the PC in perpetuity thereafter. And it will still have an old hard disk and graphics card, so it's never going to feel that special.

I have a better idea. For the same money and none of the hassle, you could buy him *Lego Mindstorms*. The programming IDE will run just dandy on your old PC. You give him *Mindstorms* and the PC together and he can build robots and learn to program them. There's no tech support for you, and when he goes on to build Skynet and trigger the robot uprising, the Terminators might be grateful enough to spare you in return.
Luis Villazon

Download the macros for this story at www.apcmag.com/magstuff.

Processing a group of similar objects in Excel

Helen Bradley explains how to easily process multiple cells, sheets and even charts in Excel using VBA.

Macros help streamline repetitive tasks which makes them a great tool to use when you have a lot of objects to process each in a similar way. So whenever you want to format a range of cells, to name sheets or change all your charts to a different chart type, you will need to write code to process that group of objects. In some cases, you'll want to process all the objects (such as all charts or all sheets in a workbook), and other times, you may want to process a user-selected range. We'll show you some ways this can be done.

COUNT AND PROCESS

One way to process a collection of objects is to find out how many objects there are and then process them using a 'For...Next' loop. This code counts the number of sheets in the active workbook and then processes them one by one:

```
Sub ProcessSheets()
Dim count, I As Integer
count = ActiveWorkbook.
Worksheets.count
For I = 1 To count
' do something to the sheet
Next I
End Sub
```

An alternative method of processing a collection of objects is to use a 'For... Each' loop. This code will achieve the same result as the previous code:

```
Sub ProcessSheets2()
Dim ws as worksheet
For Each ws in
ActiveWorkbook.Worksheets
' do something
Next
End Sub
```

While the For...Next and For...Each loops achieve pretty much the same end result one benefit of using the For...Each loop is that you don't need to know how many objects are in the collection before you begin. On the flipside, if you are using a For...Next loop, because you need to know how many objects are in the collection, you will then have a counter variable available that you can use if needed without having to specifically create one. In addition, you can process the collection in reverse when using a For...Next loop which isn't possible using a For...Each loop.

PROCESSING CHARTS

To process each chart in a worksheet, you can access the ChartObjects collection:

```
Sub processCharts()
Dim ch As ChartObject
For Each ch In ActiveSheet.
ChartObjects
' do something
Next ch
End Sub
```

PROCESS CELLS

When processing cells, you have many options. For example, you can process a known range of cells:

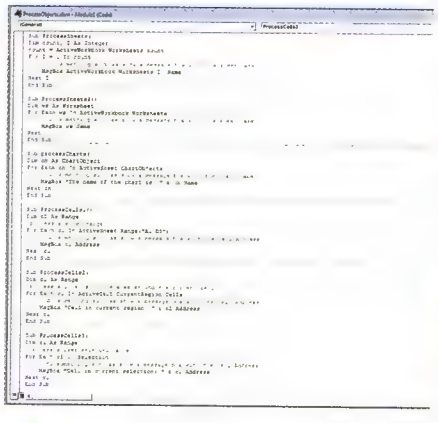
```
Sub ProcessCells ()
Dim cl As Range
'process a known range
For Each cl In ActiveSheet.
Range("A1:G20")
' do something
Next cl
End Sub
```

Replace the previous For statement with this to process cells in the region around the active cell:

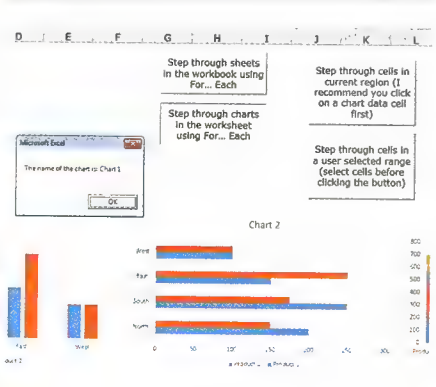
```
For Each cl In ActiveCell.
CurrentRegion.Cells
```

And replace the previous For statement with this to process the cells in a user-selected range:

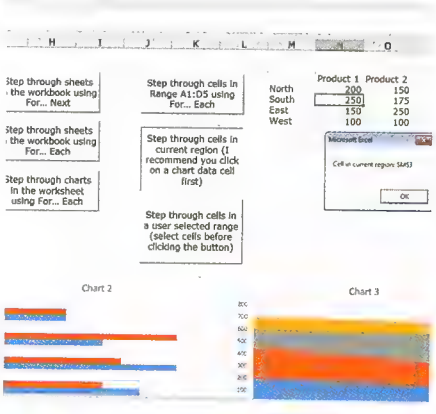
```
For Each cl In Selection
```



STEP 1
You can process a collection in Excel VBA using either a For...Next or For...Each loop.


Step through sheets in the workbook using For... Each
Step through charts in the worksheet using For... Each
Step through cells in current region (I recommend you click on a chart data cell first)
Step through cells in a user selected range (select cells before clicking the button)
Chart 2

STEP 2
One collection of objects you can process using VBA is all the charts in the current sheet.


Step through sheets the workbook using For... Next
Step through sheets the workbook using For... Each
Step through charts in the worksheet using For... Each
Step through cells in Range A1:D5 using For... Each
Step through cells in current region (I recommend you click on a chart data cell first)
Step through cells in a user selected range (select cells before clicking the button)
Product 1 Product 2
North 200 150
South 250 175
East 150 250
West 100 100
Chart 2
Chart 3

STEP 3
When processing a range of cells, you have multiple options available including processing the cells in the area surrounding the currently-selected cell.

enerate is heading to Oz! Join us for a single-day, single-track conference with talks on user experience, CSS and more

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NICK FINCK
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Automate Windows with PowerShell

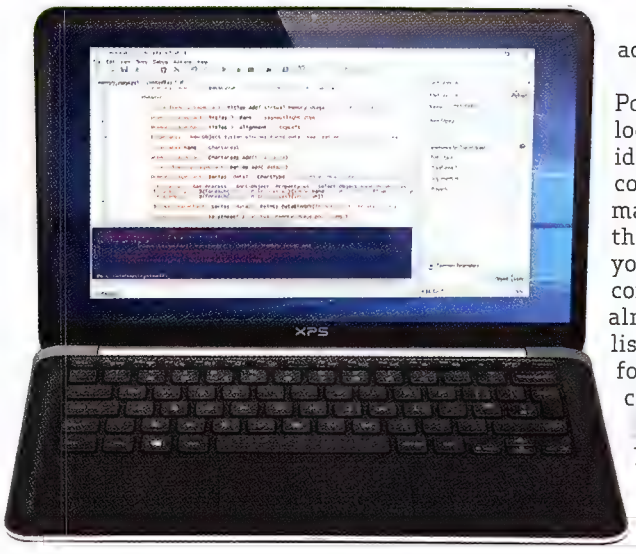
Discover how to create custom scripts so you can manage your PC the clever way.

Exploring the more advanced Windows tools is a great way to begin taking control of your PC. Learn about Task Manager, for example, and you'll soon be able to detect and, importantly, close down failing processes that might be slowing down your computer.

Relying on the standard applets presents all kinds of problems, though. You have to manually launch them every time you want to do something. Then you're forced to work your way through the interface, perhaps choosing the same settings and options, over and over again. And even after all that, the applet might not do exactly what you need.

Fortunately, there is another way. PowerShell is a powerful scripting language that enables you to take full control of every aspect of your PC. Whether you need to watch running processes, monitor the file system, tweak the registry, download files, analyse web pages, create reports or do just about anything else on your local PC or any other networked system, PowerShell can help you get the job done, as precisely as you require and as quickly as possible.

What's more, while it can sometimes be complicated, you don't have to be a programmer to begin learning a few scripting basics. In fact, if you work at the Windows command line, even occasionally, you could be carrying out useful tasks in PowerShell with just a few minutes' study.



COMMAND PROMPT

To launch PowerShell, type `powershell` into the Search box, then right-click the Windows PowerShell entry and choose 'Run as administrator'.

As you'll see, the PowerShell interface looks and feels almost identical to the standard command line. And in many ways, this is a good thing, because it means you can use all the commands you know already. Enter `DIR` to list the files in a folder, for instance, `cls` to clear the screen, or `IPCONFIG` to list your network adapters; everything works as you'd expect.

What you do get, though, is many new commands — or 'cmdlets' (pronounced 'command-lets') in PowerShell-speak — and, fortunately, there's a cmdlet to list them all. Type `get-command` and press Enter to take a look. For now, ignore the functions and look only at the cmdlets. As you'll see, cmdlets have a clear verb-noun naming structure: Start-Process, Clear-EventLog, Get-ComputerRestorePoint, Restart-Computer, and so on. This makes them quite easy to understand but, of course,

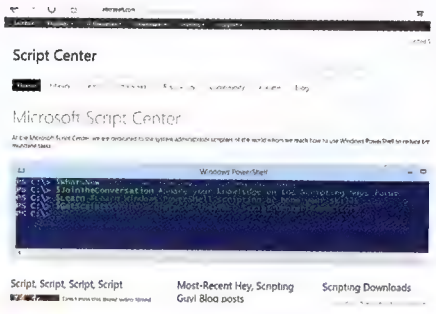
Take control of your PC

1 RUN QUICK COMMANDS

The PowerShell console supports all the usual Windows commands, so you'll be using it right away. But explore the Help system and you'll find new tools to control programs and services, manage network PCs, process files, access web content, and more.

2 BUILD POWERFUL SCRIPTS

Now you've mastered the basics, launch PowerShell's Integrated Scripting Environment (ISE) and use its straightforward editor to create longer, more powerful scripts. Launch them with a click, saving your favourites for easy recall at any time.



3 EXTEND YOUR SKILLS

Point your browser at Microsoft's Scripting Centre, and look out for interesting sample scripts. Copy and paste these into the ISE, press F5 to try them out, then read the code and try to figure out how they work — it's a great way to learn the language.

you'll often need more detail. Enter Update-Help to download and install the documentation, then use the Get-Help cmdlet, like this, to find out a bit more about PowerShell:

```
Get-Help Start-Process
Get-Help service
Get-Help clock
```

The first line displays specific help on Start-Process; the second lists cmdlets with 'service' in the name; and the third just searches the help system for any items containing the word 'clock' – great when you know what you want to do, but just aren't sure which cmdlet to use.

QUICK QUERIES

Enough of the theory; it's time to do some real work. Let's start by using PowerShell to collect some data on our system, like this:

```
Get-Process
```

As you'll probably guess from the cmdlet name, this gets a list of processes currently running on your system (just the same as you would see in Task Manager), and displays their CPU and RAM use, along with some other statistics. That's already useful, and not something you can do easily in Windows alone, but we're just getting started. Next, enter this:

```
Get-Process | Where-Object CPU -gt 5
```

As before, PowerShell is first checking your running processes. The pipeline character tells PowerShell to pass that list to the Where cmdlet. And this scans through the process list, looking for anything that matches the condition we've set – that it should have used greater than five seconds of CPU time (`-gt` is greater than; `-ge` is greater than or equal to; `-lt` is less than; `-le` is less than or equal to).

We've now filtered our original list a little, but there's still more to do. The next step is to enter this:

```
Get-Process | Where-Object CPU -gt 5 | Sort-Object handles -descending
```

We're still fetching your running processes and picking out the CPU hogs, but now PowerShell is also sorting the remaining processes by their number of handles (a measure of how many files, memory blocks and other objects a process has open). Again, this is just an example, so tweak it; sort by CPU, say, or ProcessName (the column headers at the top of the Get-Process list will give you an idea of the names you can use).

POWERFUL REPORTS

As you can see, there are plenty of ways to customise and filter whatever PowerShell returns, but there's a problem: we're still only getting plain text results. So try this:

```
Get-Process | Where-Object CPU -gt 5 | Sort-Object handles -descending | Out-GridView
```

Now PowerShell doesn't only filter and sort the list; it also displays the results in an interactive grid. You can hide, re-order or sort columns, and filter your data in various ways. And once you're happy, any selected rows can be copied to the clipboard, ready for using anywhere else.

This isn't bad for a single line of code and, of course, you can have as many lines as you need, but there's more. Because PowerShell cmdlets work in such a consistent way, you can take this example and reuse it almost immediately. Take a look at these examples:

```
Get-Winevent System | Where-Object LevelDisplayName -eq "Critical" | Out-GridView
Get-Service | Where-Object status -eq "running" | Sort-Object displayname | Out-GridView
```

The first gets the contents of the Windows System log, looks for critical errors and displays them in a table. The second fetches our running services, again sorting them to suit our needs. And both examples can be further tweaked and customised in many different ways.

TAKE CONTROL

PowerShell provides plenty of sorting and filtering options, then, but it's not just a passive reporting tool. Take a look at this:

```
Get-Service | Out-GridView -Title 'Select service to restart!' -OutputMode Single | Restart-Service -WhatIf
```

We're getting a list of installed services, and displaying them with a custom window title as a user prompt. The '-OutputMode Single' switch tells PowerShell that we're allowed to select one item in the list. If we do this, and click OK, our chosen service is passed along the pipeline to the next cmdlet, Start-Service, which stops and starts it for us, which is very useful as a way to try to revive any services that are misbehaving.

Or, at least, it would restart the service if we hadn't included the '-WhatIf' switch, which tells PowerShell to simply display its action instead. This is a handy safety option, which means you can see how a cmdlet might work without the risk of, in this case, accidentally stopping a service that really should be left alone. But if you want to try it for real, enter the same cmdlet without the -WhatIf, and you'll have created your very own custom service-restarting tool.

You can, of course, do something similar with processes, services, and any other objects PowerShell can manipulate. But even that's not the end of the story:

```
Get-Service -ComputerName MyPC | Out-GridView -OutputMode Single | Restart-Service -WhatIf
```

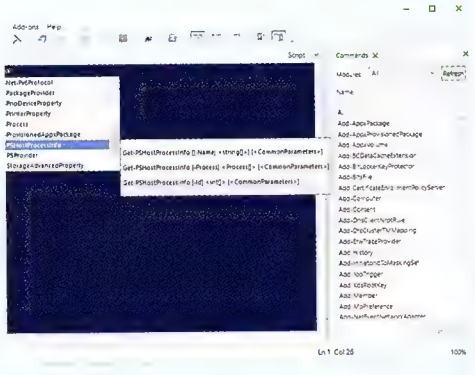
Cmdlets like Get-Service and Get-Process aren't restricted to your local system. Use the '-ComputerName' switch with the name of a network computer and you're able to see what it's running, too (assuming your Windows user account has the privileges to access them). PowerShell can then manage remote systems in exactly the same way as your own PC.

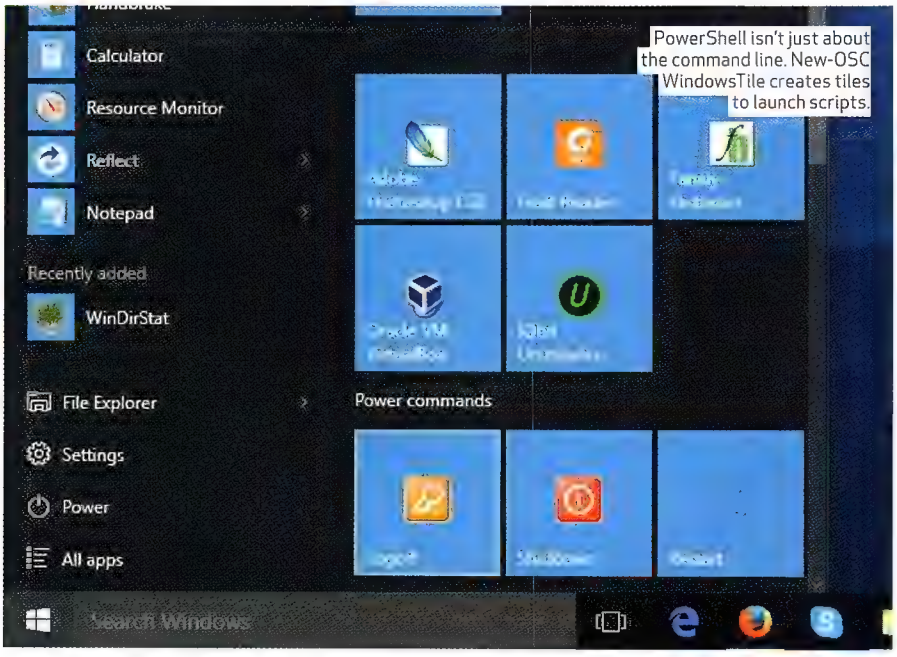
POWERSHELL ISE

So far, we've been working only in the PowerShell console, entering commands one by one and seeing the results right away. There is another way to run code, though – in the PowerShell Integrated Scripting Environment (ISE). It's a little more complex, but much better when you'd like to string several cmdlets together, or create some code for reuse later.

Enter PowerShell commands faster

Don't waste time typing long commands at the PowerShell console. Enter just a few characters (`Get-Pr` for Get-Process, say), keep pressing tab and any matches appear. Or use an alias, a shorter version of the same text; `npssc` works in exactly the same way as New-PSSessionConfigurationFile, for example. Enter `Get-Alias` to see the aliases you can use right now, and `Set-Alias` to create your own (**tinyurl.com/apc432-alias** has useful examples).





PowerShell isn't just about the command line. New-OSC WindowsTile creates tiles to launch scripts.

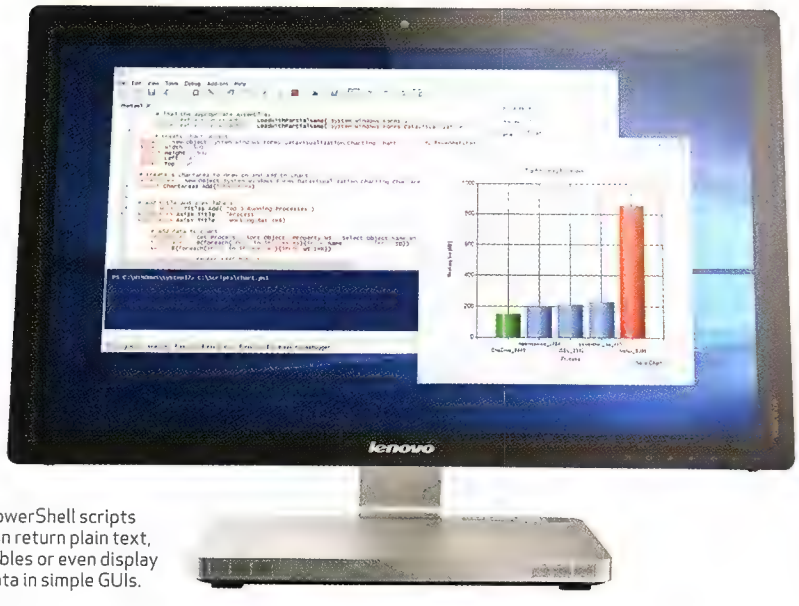
Launch it by searching for PowerShell and clicking 'Windows PowerShell ISE', entering `Powershell-ISE.exe` in the Run box, or by entering ISE at the PowerShell console.

The ISE opens with a two-pane interface. On the left is the console, where you can enter PowerShell commands. On the right is the Commands Add-On, a handy tool that can help you build commands with the mouse.

Type `process` in the Commands 'Name' box; you'll see various matching cmdlets. Select 'Get-Process' to see its parameters, helping you understand what the cmdlet can do. Click the 'Name' tab, for instance, and you'll find a Module box. What does this do? Check it and click 'Run'. The Commands Add-On builds the cmdlet Get-Process -Module, runs it in the console, and displays the results – a list of all your processes, where each one includes its loaded modules (DLLs and other support files).

While this can be helpful, the ISE console also has some extra tricks to speed up your PowerShell coding. Begin typing a cmdlet (try Get-Process again) and ISE displays possible matches. By the time you've reached Get-Pro, the correct cmdlet should be highlighted, and you can press Tab to automatically enter the remaining characters.

It's a similar story when it comes to entering parameters. Tap the space bar, then a hyphen, and ISE lists the various Get-Process options. Use the cursor keys to scroll down, then select '-Module', press Enter and again it is automatically added to your command, no typing required. As you can see, there's more to learn in the ISE, but it does also make it easier to explore what PowerShell has to offer. Now we just have to use it to build a script.



PowerShell scripts can return plain text, tables or even display data in simple GUIs.

SCRIPTING

Click 'View > Show Script Pane' to reveal the script pane. This is a separate area where you can enter a string of commands, across as many lines as necessary, without having them executed immediately. Instead, you can run all the commands in the Script pane at any time by pressing F5 or clicking 'Debug > Run'.

To give this a try, enter the following four commands into the Script pane.

```
$computername = read-host "Which computer name would you like to check?"
$os = Get-WmiObject -Class Win32_OperatingSystem -ComputerName $computername
$lastbootuptime = $os.ConvertToDateTime ($os.LastBootUpTime)
Write-output "$computername last boot time was $lastbootuptime"
```

This is a simple script, which tries to find out the last boot time for whatever network computer you specify. Although very short, it's much more advanced than our previous code, and introduces several new concepts.

The first line, for example, uses the read-host cmdlet to display a prompt, asking the user to enter a computer name. This is then stored in a variable called $computername.

The second line uses WMI to retrieve the operating system for the specified computer, while the third then obtains its boot time and converts it into a readable format. (Don't worry about the technical details here; all you really need to remember is that Get-WmiObject can return useful information about your system configuration.)

Finally, the last Write-output cmdlet sends a message to the console. The variables will be replaced by their actual values so, for example, you might see "MyServer last boot time was 06/10/2014 08:30".

Press F5 to launch the script. If you can access a networked PC, enter its name, otherwise enter localhost or just a period to check the local system. And that's it – your first multi-line script. Click 'File > Save As' and save it as C:\Scripts\LastBootTime.ps1 (creating the folder, if necessary), ready to be recalled whenever you like.

SCRIPTING

Our sample ISE script was very small, but the principles can be used to run whatever you like. Visit the Microsoft

Scripting Centre (**technet.microsoft.com/scriptcenter**) – or search for PowerShell Scripts – to locate more examples, copy and paste them into the scripting pane, and press F5.

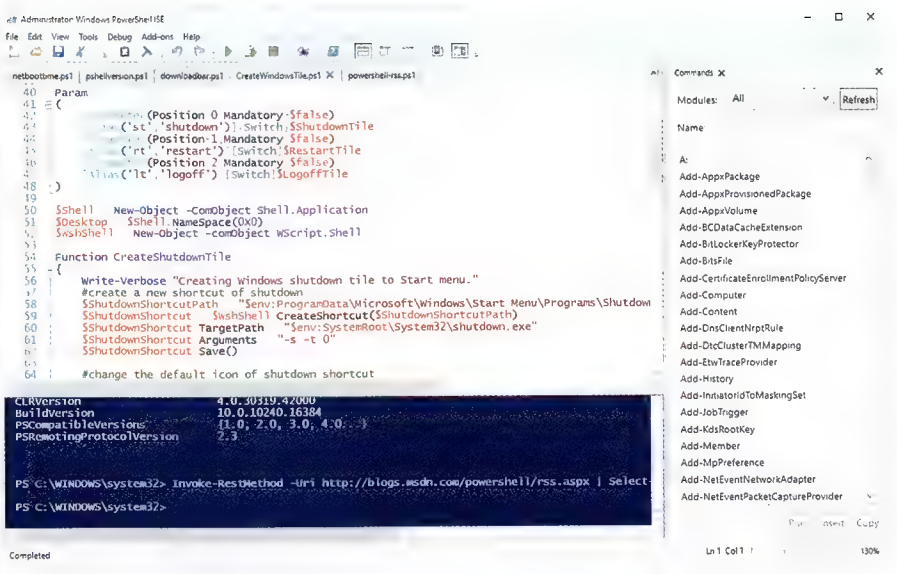
There is still one issue remaining, though: how can you run the script outside of PowerShell? Double-clicking it seems an obvious solution, but try this and the file opens in Notepad; less than helpful.

You could relaunch PowerShell and enter C:\Scripts\LastBootTime.ps1 at the command line, but that won't work, either. You'll just see a message complaining that "running scripts is disabled on this system". This is normal; the default security settings place strict limits on scripts to prevent their abuse by malware.

To get around this problem, you need to find out more about PowerShell's execution policy. The following cmdlets will help:

```
Get-ExecutionPolicy
Set-ExecutionPolicy
RemoteSigned
```

The first line should tell you that your policy is set to 'restricted', blocking scripts. If so, entering the second line sets execution policy to 'RemoteSigned', instead. This means your own scripts will run immediately, but any scripts you download will need to be digitally signed by a trusted publisher.



Test the new policy by entering C:\Scripts\LastBootTime.ps1 again, and this time your script should run. If it's too much hassle to enter the full path each time, just add C:\Scripts (or whatever folder you choose for your scripts) to your PATH environment variable (press Windows-X, click 'System > Advanced System Settings > Environment Variables', double-click 'Path' in 'System Variables', then add a semi-colon and the folder – ;C\Scripts – to the end of your path).

This isn't quite the end of the story. The official PowerShell library (**tinyurl.com/apc432-library**) has some useful details on executing scripts, and there's a neat trick you can use to launch scripts from a shortcut (**tinyurl.com/apc432-shortcut**), but otherwise, you now know how to test, write and run PowerShell code. It's time now to begin some serious scripting.

PowerShell tips and tricks

FASTER EDITING

If you need to reuse a PowerShell command, don't waste time retyping it. Press F7 to view your recent history, select a command, press Enter to run it, or the right arrow to place it on the command line. See **tinyurl.com/apc432-editing** for more editing shortcuts.

USE COMMENTS

Adding comments to your PowerShell scripts will help others understand what they do (or act as a reminder for you). Type a # character and whatever you enter for the rest of that line will be treated as a plain text comment and not processed as code.

ACCESS CONTROL PANEL

PowerShell can access Windows components, as well as files. Use Get-ControlPanelItem to get a list of Control Panel applets, and something like Show-ControlPanelItem *display* to launch one.

RECORD A POWERSHELL SESSION

Reviewing what happened in a PowerShell session can help the learning process. Enter the cmdlet Start-Transcript and all your console activities (including any output) are saved to a text file in your Documents folder. Enter Stop-Transcript to stop recording.

SCRIPTED DOWNLOADS

Need to download a file from a script? This is the easy way (see **tinyurl.com/apc432-dload** for something smarter):

```
$client = New-Object "System.Net.
WebClient"
$client.DownloadFile("http://domain.
com/bigfile.zip","c:\temp\bigfile.zip"
```

SEND EMAIL

You don't have time to monitor everything your scripts are doing? You could set them up to send you an email, instead. Check the Send-MailMessage cmdlet for a basic example, or Peter Morrisey's blog (**tinyurl.com/apc432-email**) for something more powerful.

GET EXAMPLES

If you're not sure how to use a cmdlet, use the 'Get-Help -examples' switch, such as 'Get-Help Invoke-WebRequest -examples', to learn more.

RSS READER

The Invoke-RestMethod cmdlet can access the RSS feed of any web source and manipulate it however you like. Here's a quick way to view what's happening in Microsoft's PowerShell blog:

```
Invoke-RestMethod -Uri http://blogs.
msdn.com/powershell/rss.aspx | Select-
Object Title, Link | Out-GridView
```

PROCESS FILES

To process text files, use Get-Content to read them, manipulate the content how you want (see **tinyurl.com/apc432-text**) and use Set-Content to save changes. Mistakes could result in lost data, though — only work with copies of files until you're sure you know what you're doing.

RUN SCRIPTS AUTOMATICALLY

If you become a PowerShell master, you could even set up Task Scheduler to run scripts automatically, whenever you like. Read up on the New-ScheduledTaskAction, New-ScheduledTaskTrigger and Register-ScheduledTask cmdlets, and see **tinyurl.com/apc432-run** for an example. ■

Create an iOS workflow to find Pokémon

Frustrated with the limitations of current Pokéhunting tools, Matthew JC. Powell takes things into his own hands.

If you are among the hordes wandering the streets in pursuit of elusive Pokémon lately, you will have noticed that *Pokémon GO*'s built-in feature for finding Pokémon – the 'Nearby' button in the lower-right of the screen – doesn't actually work.

In response, a website called **pokevision.com** has popped up, using slightly dodgy techniques to extract location data for individual Pokémon from Niantic's servers and display the locations on a map. It's pretty good, but it also has limitations. For instance, there's no way to search for particular Pokémon.

Enter Workflow (**workflow.is**). Using Workflow, you can grab data from PokéVision and overlay it on Google Maps for up-to-date accurate mapping, as well as an estimate of walking time. What's more, you can add PokéVision's missing search function to find just what you need.

It's important to note that what PokéVision does – and, therefore, what this workflow does – violates Niantic's terms of service for the game by extracting raw data from its servers. Niantic may choose to take action against players who utilise such means. Proceed at your own risk.

Choose a Pokémon
Cancel
Choose
Done
Geodude at 0.63km away for 1 minutes
Nidorino at 0.743km away for 3 minutes
Rhyhorn at 0.71km away for 5 minutes
Ponyta at 0.684km away for 2 minutes
Pidgey at 0.64km away for 12 minutes
Machop at 0.538km away for 1 minutes
Zubat at 0.253km away for 6 minutes
Nidoran ♀ at 0.279km away for 8 minutes
-->Charizard at 0.792km away for 3 minutes
Pidgeotto at 0.852km away for 12 minutes
Bellsprout at 0.837km away for 11 minutes

Worth the trip? See that Charizard there? If your name is Noah Ngeny, you can cover that distance in that time. If not, don't bother. See how helpful this is?

First, let's add that search function. From Workflow's actions list, get the action called 'Ask For Input' and drag it to the right. Give it a question to ask, such as 'What Pokémon do you need?' And set the input type as Text.

Since you might want to search for multiple Pokémon, drag over the action called 'Split Text' and make the Separator 'new lines'.

Next, get the action 'Set Variable' and name this variable 'needed'.

Next, we have some typing to do in order to query the PokéVision server. Grab the action called Text and drag it over. Into it, you're going to want to type the number and name of every Pokémon in the game – all 151 of them at the moment – in the following format: {"1":"Bulbasaur","2":"Ivysaur"} and so on, with curly brackets at the start and finish.

See **www.apcmag.com/magstuff** for the whole thing and thank Niantic for not including all 721 yet.

Next, drag over another Set Variable action and call this one 'poke_names'.

Now for the mapping. Drag the action Get Current Location, then another Set Variable and call this one 'location'.

To compare your location against that of the various Pokémon, drag the action Get Variable over and tell it you want to get the value of 'location'. Drag over 'Get Details of locations' and tell it you want latitude. Then drag over another Set Variable and tell it to call this variable 'latitude'.

Repeat the above steps for longitude.

Next, drag over the action called URL and enter "**https://pokevision.com/map/data/latitude/longitude**". The latitude and longitude have to be entered as variables, so that PokéVision will use the data about your location you've just collected. When typing the URL, tap the 'Variable...' button above the keyboard to see which variables have been defined and select the ones you need. It may take a couple of attempts to get it to accept both variables.

Then drag over the action 'Get Contents Of URL' and then the action 'Get Dictionary From Input'. That last one takes the data from PokéVision for your longitude and latitude and turns it into a text file in the same format as the list you created earlier.

Drag over another Set Variable and call this one 'url_output'. Next, drag over the action 'Get Value For Key' and call the Key 'pokemon'. Drag over another Set Variable and call this one 'pokemon_list'. Drag over a 'Count' action and tell it to count items.

Next, we're parsing the Dictionary we extracted from the URL to get data we can plug into a mapping application. Drag over a Get Variable action, and get the variable called 'pokemon_list'.

From the Scripting section of the actions list, grab 'Repeat With Each' and drag it over. The following steps need to be repeated with every item in that list.

You want to set a variable called 'item', then get a value for key and call the key 'pokemonid', then set a variable called 'item_id'. Next, get the variable 'poke_names', get a value for key and tell it to get the value for 'item_id'. Then set a variable called 'item_name'.

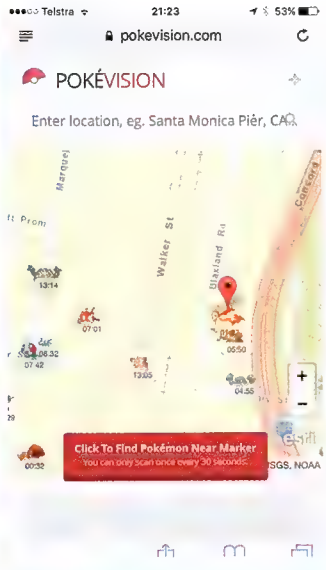
Next, drag a Get Variable and set it to 'item'. Drag a Get Value For Key and set it to 'latitude'. Drag a Set Variable and call it 'item_lat'. Repeat those steps for the longitude.

Now we're interested in how long the items are going to be there. This is tricky, because PokéVision actually calculates the time from 1 January 1970 at midnight. This may be a bug and may change, so if it does, this workflow will break. Bear that in mind.

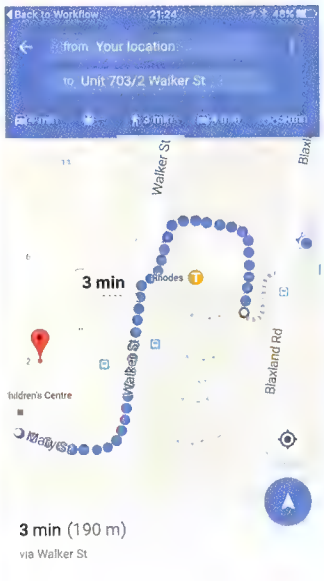
Drag a Get Variable and once again get the variable called 'item'. Drag a Get Value For Key and call it 'expiration_time', then drag a Set Variable and call it 'item_exp_sec'.

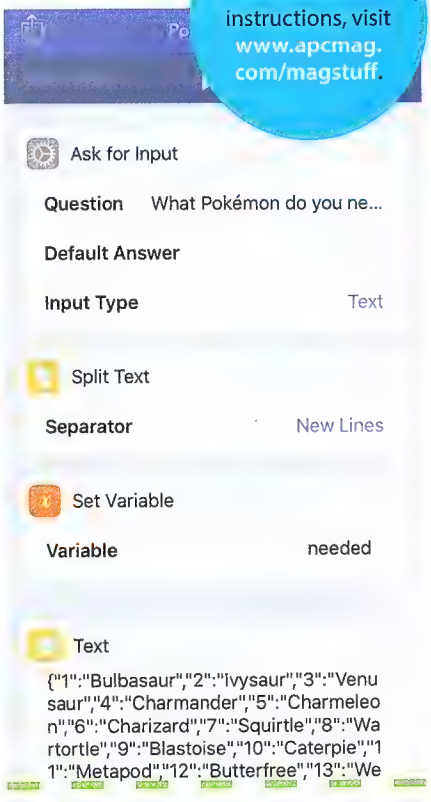
Next, drag over a 'Date' action, and tell it to use a specified date: 1 January 1970 at 12am. Then drag over an 'Adjust Date' and tell it to add 'item_exp_sec' seconds (the keyboard will give you the option to insert the variable there).

Next, adjust for your time zone. Drag another 'Adjust Date' action and add your difference to GMT. For



With *Pokémon GO*, you can see there is a Clefairy nearby, but you don't know how far or in what direction to travel. With PokéVision, you can find it, but the view on a smartphone screen is tiny and it's not clear how you can get to it. Using this workflow and Google Maps, it's a simple matter of a three-minute walk and you know whether to turn left or right. Unfortunately, Apple Maps doesn't know you can cross the railway line at the station.





example, Sydney at this time of year is GMT +10, so add 10 hours. You'll need to fix this when Daylight Saving starts.

To find how long a Pokémon is going to be available, drag a 'Get Time Between Dates' action, and tell it to get time from right now in minutes (you can get the time in seconds if you prefer). Then drag a Set Variable action and call the variable 'item_exp_diff'.

Next, drag over a Text action and put in the two variables 'item_lat' and 'item_lon' separated by a comma. This will act as input for the next action, which is 'Get Distance'. Tell it you're walking (because driving to hunt Pokémon is weird) and distance in kilometres because this is the 21st century. Drag a Set Variable action over, and call it 'item_distance'.

Next, we want to set a variable called 'item_needed', but to avoid the wrong data being set to its value insert a blank Text action, then drag over a Set Variable and call it 'item_needed'.

Drag over a Get Variable and tell you want 'needed'. Then drag over 'Repeat With Each', followed by 'If'. Tell it to check if input contains the variable 'item_name', then drag over a Text action. Into that text box' type a symbol that will appear before any Pokémon that you specified at the start that you needed. For example, "->". Then Set Variable again and define 'item_needed'.

To close the loop, drag over an 'Otherwise' and then an 'End If', followed by 'End Repeat'. Whew! Almost done.

Next, make a list of nearby Pokémon. Drag over a Text action, and type the text as it appears in the screenshot of this workflow. To enter the variables, tap the 'Variable...' button that appears on the keyboard. Drag over a Set Variable action and call the variable 'item_label'.

Get another Text action, and type the following: {"lat_lon":"item_lat,item_lon"}. Note that 'item_lat' and 'item_lon' are variables. Then drag over another 'Get Dictionary From Input' action, then a 'Set Name' action. Set the name of the dictionary as the variable 'item_label'. To close the loop, drag an End Repeat action over.

Drag over a Set Variable action and call the variable 'list'. Drag over a Repeat action and tell it to repeat 10 times (or however many nearby Pokémon you want it to list at once). Next, drag a 'Choose From List' action, type in the prompt "Choose a Pokémon" and select whether you want to be able to select more than one at once. One at a time is much easier.

Drag over a Get Value For Key action, and set the value as 'lat_lon'. Drag over a 'Show Directions' action and tell it to use Google Maps and Walking as the mode of transport. Sorry if you're an Apple Maps loyalist, but its walking directions are terrible.

Finally, drag over a 'Wait For Return' action. This tells Workflow not to quit just because you've changed apps (by looking at Google Maps) so when you return to Workflow the list will still be there.

And finally, close the last repeating loop with an 'End Repeat' action.

Now run it and see how much easier it is to find Pokémon this way. Use the Settings icon to save your workflow – give it a name and an icon and save it to your Home screen to use as an app without having to start Workflow first.

Note, of course, that this workflow is dependent on not one but two external servers – Niantic and PokéVision. Unfortunately, if either or both of them aren't working, neither will this.

The modern gaming machine

APC builds an ideal mid-range system, designed to get you the best possible 1440p experience.

What got you into PCs in the first place? Can you remember? For many of us here at *APC*, it was gaming. As much as we are all professionals here in the office, utilising a wide-ranging cornucopia of software in our lives, ultimately, it was controlling a plethora of pixelated characters over the years that drew us into a world of higher frame rates, customisation, and the best experience possible on a desktop.

And that's exactly what this build is all about. Getting back to our roots, piecing together a rig that is centred around a respectable GPU and a gaming workhorse of a CPU.

For the previous three generations of Nvidia GPUs, the premium best-value option from team green has centred around the x70 series of cards. Whether that's the GTX 770, 970 or now the 1070, these graphical processors have always pushed their respective target resolutions to the very pinnacle of frame rate success. Then, of course, there's your choice of processor. The general rule of thumb has been that, unless you're making money of out of hyperthreading, you simply don't need it. The Core i5 processors have valiantly held aloft the heads of many a talented gamer, those looking again for the best-value premium processor at exactly the right price.

THE GAMER'S DREAM

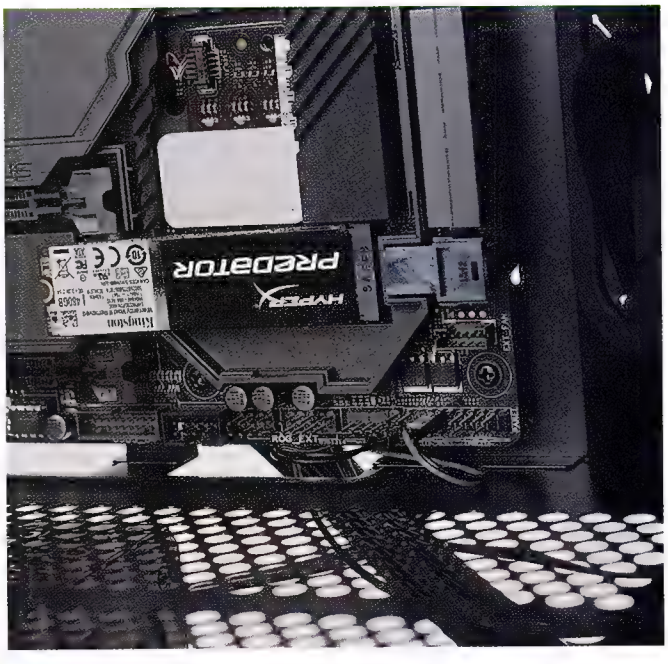
Let's cut to the chase. This little beastie of ours houses the aftermarket MSI GeForce GTX 1070 Gaming X, overclocked at stock to provide just a touch of extra boost clock — far quieter, cooler and gamier than its Founder's Edition compatriot. On top of that, we've coupled it with Intel's Core i5-6600K, clocked at a lovely 4.4GHz. The legendary quad-core i5 series processors have been at the heart of many a gamer's rig since the launch of Sandy Bridge, way back when, and not a lot's changed. With an exceptional overclocking range, and strong single-core performance, is it any wonder that these are still the gamer's processors of choice? To round all that out, we went with an ASUS Maximus VIII Formula motherboard, 16GB of Crucial Ballistix Elite DDR4 @ 2,666MT/s, a Kingston HyperX Predator 480GB PCIe SSD for the OS, plus crucial games and programs, and an additional 960GB of SSD storage in the form of the Crucial BX200. All sitting snugly inside the Phanteks Enthoo Evolv ATX Black tempered glass chassis, which is an absolute dream to work in — roomy and flexible.

There are a few little extras — this time around, we opted to stay with the stock Phanteks fans in the roof and rear of the chassis, still utilising two Noctua NF-F12 iPPCs for the mighty Corsair Hydro H100i V2.

PARTS LIST

PART		STREET PRICE
CASE	PHANTEKS ENTHOO EVOLV ATX GLASS	$279
MOTHERBOARD	ASUS MAXIMUS VIII FORMULA	$649
CPU	INTEL CORE I5-6600K @ 4.4GHZ	$349
MEMORY	CRUCIAL BALLISTIX ELITE 16GB (2X 8GB) @ 2,666MT/S	$129
GPU	MSI GEFORCE GTX 1070 GAMING X	$769
PSU	CORSAIR HX1000I	$309
STORAGE 1	KINGSTON PREDATOR 480GB M.2 PCIE SSD	$399
STORAGE 2	CRUCIAL BX200 960GB	$399
COOLING	CORSAIR HYDRO H100I V2 PLUS 2X NOCTUA NF-F12 IPPC 120MM 2,000RPM FANS	$227
TOTAL		$3,509

"There's never a right answer when it comes to component selection. It depends on what you need the system to do..."

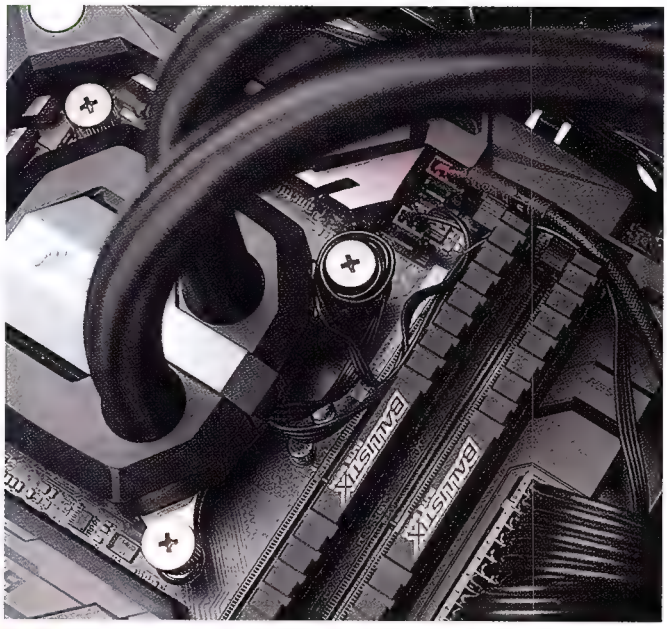


1 SMUDGES, SMUDGES EVERYWHERE

We absolutely love this chassis here at *APC*. What Phanteks managed to achieve with the Evolv ATX was simply incredible, especially for those wanting to build a clean, good-looking system with an AIO cooler. The room to move and the quality of the aluminium panels is simply amazing. One thing to bear in mind, however, if you do opt to get the tempered glass version we've featured here, is that those glass panels will smudge. We don't want to put you off; it's just a warning — this baby will require a ton of spit and polish to get it into shape after you're done. It's almost worth wearing gloves, just to avoid getting your grubby fingermarks on that panel. The aluminium panels do stain a bit, too, but it's nothing a little isopropyl alcohol or window cleaner won't get rid of.

2 HIDDEN PCIE SSD

You simply can't beat PCIe SSDs. Even the ones at the cheaper end of the spectrum — such as this 480GB HyperX Predator drive — easily outclass even the most hardy of SATA-based SSDs. So what's the problem? Well, they're hardly the cleanest-looking components. Even Samsung's ever-popular SM951 editions tend to house a green PCB, and despite the black styling of the Predator, and the likes of the new 950 Pros that have recently been released, they're just a little too garish for those looking to build a super-clean system. Say hello to the Maximus VIII Formula's secret weapon, then. A simple, small Phillips screw and a quick yank later — wham! Super-stealthy, hidden M.2 storage under the Formula's Thermal Armor. The word 'classy' doesn't quite cut it.

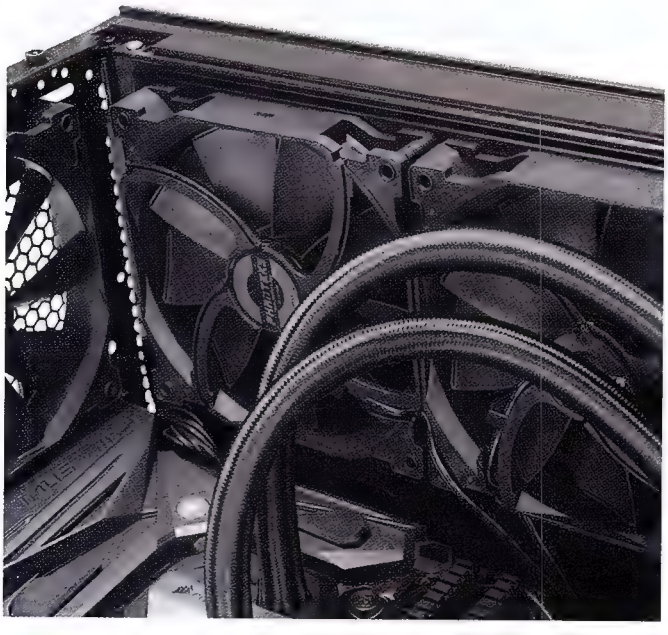


3 CPU COOLER CABLING

There are usually two ways to get around messy CPU block cables stemming from those mighty AIOs. Either you luck out with your case/motherboard combo, and can stretch them far enough out the way, or you can tie them up into a little nice loop. Unfortunately, that didn't work for us here, and it ruined our style a little. So to compromise, instead of wrapping the cables around in a loop as usual, poking out from the sides of the DDR4, we opted to actually wrap them around one of the Hydro's mounting thumbscrews. Is it perfect? No, but it's a lot better than it was.

4 CABLE MANAGEMENT NEEDED

There's a couple of nifty features that the Evolv ATX employs to help keep your cables tidy round the back of the chassis. Those Velcro straps are godsends, and mounting SSDs on the rear of the motherboard tray is a stroke of genius. Couple that with a simple fan hub controlling up to eight fans, and we're on to a winner. Only problem? Well, there's that tempered glass to deal with yet again. Although it's smoked, you can see through it, so your cable management will certainly need to be on point to ensure your rig looks as respectable round the back as it does at the front.



5 POSITIVE PRESSURE

We can't emphasize this enough. Positive pressure, positive pressure, positive pressure. Trust us—you'll thank us later. Having a positive pressure fan setup improves internal case temperatures, and helps reduce the amount of dust build-up inside your chassis, meaning it's a lot easier to clean. Thanks to the majority of our fans blowing air into our system, sucking cool air in through dust filters, any air inside the chassis is exhausted and pushed out of the unfiltered areas and gaps, stopping dust from entering your chassis when the system is running. Neat, huh?

6 INSTALLING THAT MIGHTY GPU

Warning: This is not how you install a GPU; this is how you take a photo of installing a GPU. It turns out, that's quite difficult to make look good. Ensure you remove your PCIe cover on the bottom of the card, remove the two screws holding the PCIe brackets in place, and gently slot your card into the PCIe slot. Then use the same screws to tighten the GPU down, plug in your eight-pin and six-pin power, and voila — you're all done and ready to game. It's rare to have any problems when it comes to installing GPUs; however, some of the heavier cards — Zotac's Arctic Storm comes to mind — might come with a reinforcing bracket or pole to ensure the weight of the card doesn't put too much strain on the motherboard, and also to avoid GPU sag.

1 If we've said it once, we've said it a thousand times: custom cable kits always make a build pop. We'd have loved to have gone with some custom sleeved cables here. If you haven't got the time, there are plenty of modders out there happy to sell you custom sleeved cables. Even Corsair sells them; alas, without cable combs to keep them tidy.

2 Radiator orientation is something that you'll constantly get criticised for. Apart from fan orientation and pressure systems, it's one of the most controversial and heavily debated topics on the internet. In our experience, however, whether you mount in the roof or the front of the chassis really doesn't make a huge difference, especially in a positive system.

3 One problem we had with this particular combination of motherboard and case was with the USB 3.0 front panel connectors (just south of the 24-pin ATX power). As you may have noticed, there's no grommet directly opposite it, and because the USB 3.0 front panel has such a stiff cable, we opted to not plug it in at all. A little inconvenient, but not the end of the world.

4 We'll admit that the 1,000W PSU is overkill for this build. Especially considering how quiet even Corsair's RX series power supplies are. A Corsair RM650 would've been plenty, even with those mighty overclocks chunking away at the Intel Core i5-6600K and GTX 1070.

The gamer's powerhouse

The true beauty of personal computing lies within the community. Shocking? Think about it for a moment. Ask yourself, what is a 'good' PC? It's no easy question. After all, you could drop $20,000 on parts, and piece together a masterfully crafted silicon monster capable of rendering the world asunder with its mighty 48-thread processors. But is that a 'good' PC?

To us at *APC*, maybe. But to the 12-year-old setting his sights on his first gaming system, or the sound engineer looking for a new recording studio setup, or the pensioner after an HTPC for the den? Probably not.

And that's what's so fantastic about our community – there's never a right answer when it comes to component selection. It depends on what you need the system to do, what games you play, what programs you use, what resolution you run at.

With this machine, however, in our eyes, it's one of the best mid- to high-end gaming PCs you could set your sights on. There's a few things you could change to make it cheaper, or increase cost and performance, but for 1080p and 1440p, it's nigh-on perfect. It's crisp and clean, the Phanteks Enthoo Evolv ATX chassis was fantastic to work inside; it did have a habit of picking up fingerprints, but that's par for the course with glass and aluminium. Cable management was excellent, and the extra mounting points for hiding SSDs were neat.

As far as the system goes, it does lean a little on the extreme side of component selection. It would be possible to achieve the same performance with, say, an air cooler or a lower-specced card. MSI's Gaming X variant of the GTX 1070 is around $20 more than even the Founder's Edition, but you'll still be able to get a GTX 1070 with a reference PCB and a dual-cooler for around $430 once stock makes it to market. Couple that with a 650/750W power supply, and a smaller PCIe SSD, and you're on to a winner real fast.

As for performance, we were impressed with the Intel Core i5-6600K. Although we didn't push it to its absolute limit, that impressive overclock, up to 4.4GHz, was more than enough to keep the frame rate gods happy. And it wasn't too far behind the Core i7 in our zero-point. Pretty nifty.

The big winner here was the GeForce GTX 1070. What a card! For value for money, it's the king of cool right now. Again, we didn't overclock it, but it's possible to get 2,000MHz-plus on this beauty, for some impressive gains on the average and minimum frame rate front. The HyperX Predator let us down a bit, with read and write speeds comparable only to that of a two-disk RAID 0 setup. That aside, we ended up with one nippy system, more than capable of some thoroughly enjoyable gaming at 1440p.

BENCHMARK RESULTS

	LABS SYSTEM	THIS SYSTEM
CINEBENCH R15 MULTITHREAD	987	727 (-26%)
CINEBENCH R15 SINGLE THREAD	196	189 (-3%)
TECHARP'S X264 HD 5.0.1 (FPS)	21.93	17.95 (-18%)
PC MARK 8 CREATIVE	7,675	8,937 (16%)
RISE OF THE TOMB RAIDER	41	57 (39%)
FAR CRY PRIMAL	76	93 (22%)
THE DIVISION	78	87 (12%)

Our *APC* Labs system uses a Core i7-6700K CPU @ 4.6GHz, an AMD R9 Fury X, and 32GB of RAM. All games were tested at 1080p on max settings, with HD texture packages installed.

Visualise data with Mathematica and a Pi

Jonni Bidwell shows what the Pi edition of Mathematica can do with your numbers homework.

Mathematica is a fearfully powerful symbolic computation package. It's published by Wolfram Research, and has been on the scene for over 25 years, during which time it has seen heavy adoption by both academia and industry. Powered by the general-purpose Wolfram Language, it provides a simple platform that can solve, simulate, approximate or decorate pretty much anything you throw at it.

While Raspberry Pi **[Image A]** users are not usually inclined toward proprietary software (we much prefer free and open-source), we make an exception in this case because Wolfram made the decision, in November 2013, to release a free version of Mathematica (and indeed the Wolfram Language) for the Pi. If your views on free software are sufficiently austere, then consider yourself free to not use it.

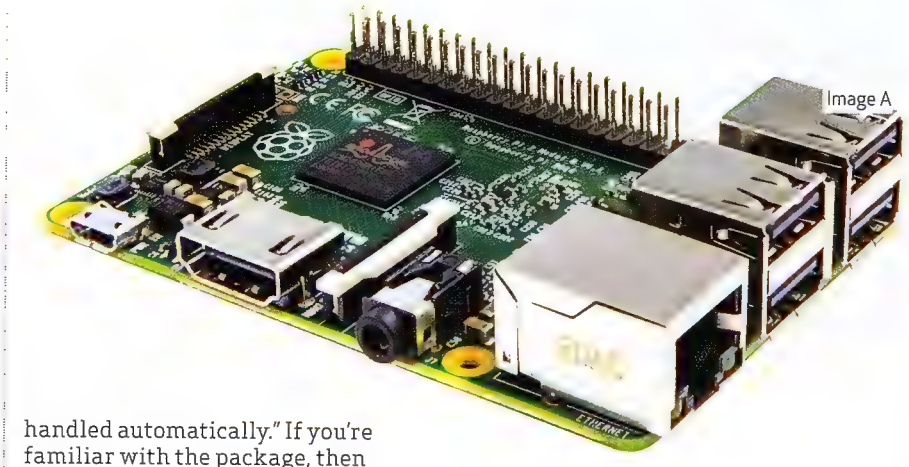


Image A

INSTALL MATHEMATICA

Still here? Okay, then, if you have a reasonably new release of Raspbian, there's good news: You already have Mathematica **[Image B]** installed. If not, you can get it with a simple:

```
$ sudo apt-get update
$ sudo apt-get install
wolfram-engine
```

Make sure you have enough space, though, because the whole install weighs in at about 600MB.

UP AND CALCULATING

The package installs two different programs for you: Mathematica and Wolfram Language. Mathematica starts a notebook-style graphical interface, while Wolfram Language starts a terminal-based one. The Wolfram Language is instrumental in powering the Wolfram Alpha knowledge engine, as well as the new Wolfram Programming Cloud. It strives to maximise automation and unification with the goal that, in Stephen Wolfram's own words, "Once a human can express what they want to do with sufficient clarity, all the details of how it is done should be handled automatically." If you're familiar with the package, then beware – to quote Stephen again: "The Raspberry Pi is perhaps 10 to 20 times slower at running the Wolfram Language than a typical current-model laptop, and sometimes even slower when it's lacking architecture-specific internal libraries." In other words, you should prepare to be patient.

TRY SOME CALCULATIONS

We'll begin by showing the basics of Mathematica. In its simplest form, you can use it as a calculator. Click on the worksheet, and type "3 + 2" (or some other suitably complicated expression) at the `In[1]:=` prompt, press Enter or select 'Evaluate Cell' from the 'Cell' menu, and you should see something like `Out[1]=` followed by the correct answer. Naturally, the program is capable of much more taxing calculations. Try "2014 ^ 2013," and be amazed at how quickly the little computer spits out a big answer. It would also be remiss of us not to do something pi-related here, so let's calculate the first million digits of that transcendental:

```
pi = N[Pi, 1000000];
```

DEFINE YOUR OWN FUNCTIONS

On our Raspberry Pi, this took all of 12 seconds (note that the semicolon suppresses outputting this rather lengthy result, which would significantly increase the time taken). We can define our own functions, too. For example, we could make a very naive Fibonacci number implementation like so:

```
F[0] = 0;
F[1] = 1;
F[x_] = F[x -1] + F[x -2];
```

We use the underscore to indicate that 'x' is a user-supplied argument. This function works – we can quickly work out the first terms of the sequence as 0, 1, 1, 2, 3, 5, 8, and so on – but things rapidly grind to a halt when we want to find, say, the thousandth Fibonacci number. You could write a better function, but no need to reinvent the wheel, as the following swiftly answers your query:

```
Fibonacci[10000]
```

NOW FOR EQUATIONS

Remember simultaneous equations from school? Something like solving

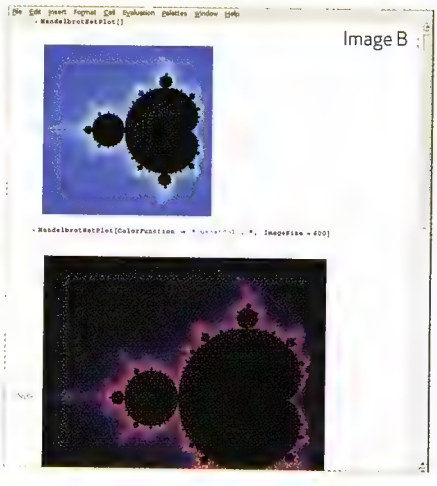
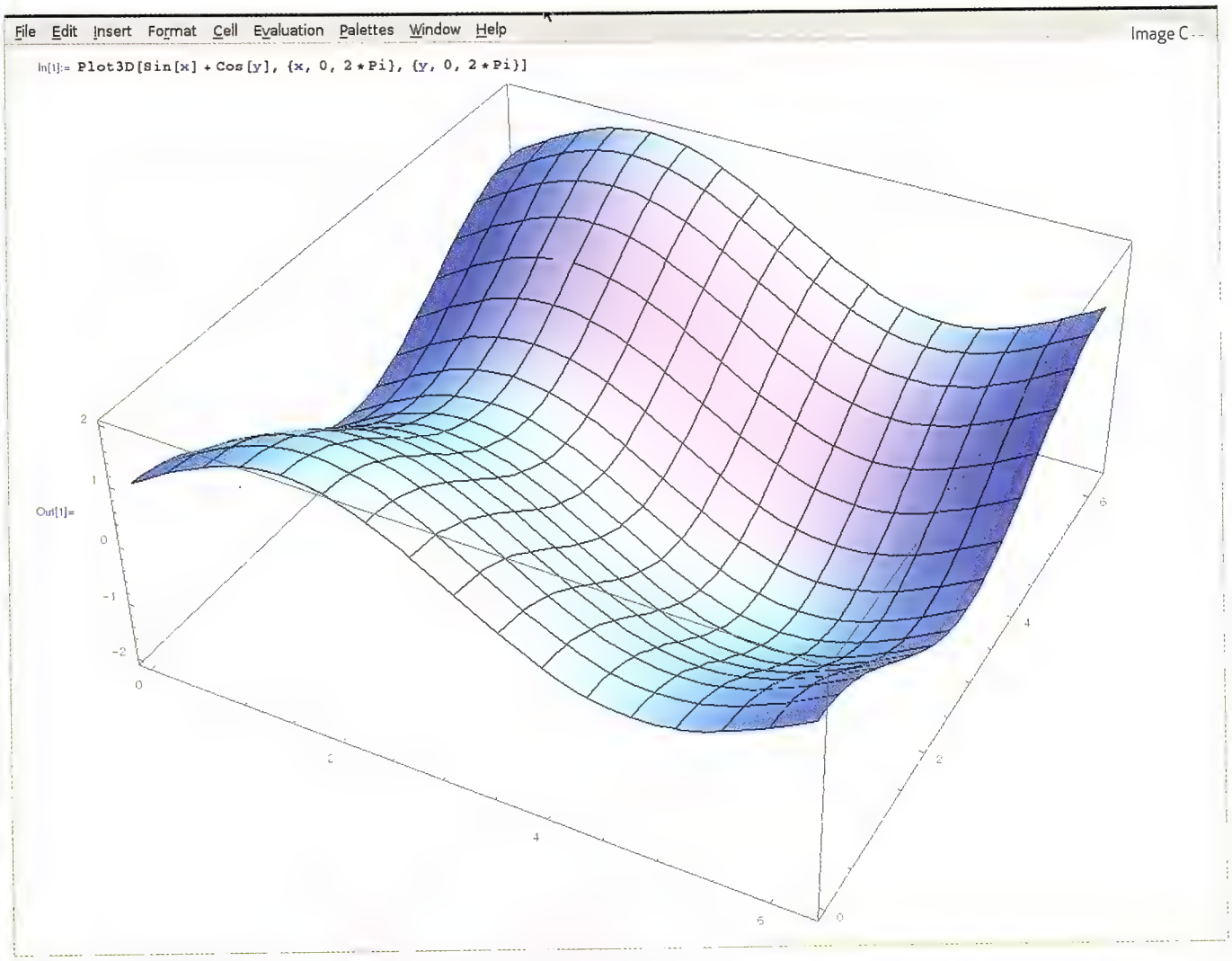


Image B



$2x + 3y = 11$ and $3x - y = 0$? While this example is child's play, if we have more variables, the situation becomes harder. We form a matrix of coefficients and, if possible, invert it. This is a tedious process to do by hand (using the method of Gaussian Elimination, which has nothing to do with classic Bullfrog title, Syndicate), commonly suffered by hungover undergrads, and involving lots of scribbling out. It is also the very same task that a significant proportion of the world's supercomputing time is devoted to, because so many models are based on linear systems.

GOING FURTHER

We can solve our basic linear system above (if you haven't already done so) with a simple:

```
m = {{2,3},{3,-1}}
minv = Inverse[m]
minv * {{11},{0}}
```

Mathematica returns the vector `{{1},{3}}`, meaning $x = 1$ and $y = 3$.

For no real reason, let's try to make Mathematica invert a 20 x 20 matrix of random floating point values.

```
m = RandomReal(1,{20,20})
Inverse[m]
```

It's nice to visualise the matrix as a rectangular array, rather than a list full of curly brackets. Doing this is a simple question of adding:

```
m // MatrixForm
```

TACKLE CALCULUS

Beside linear algebra, Mathematica can help you with your calculus homework. In particular, it's very good at integrating and differentiating things. We use the function call `D[f,x]` to differentiate the function 'f' with respect to the variable 'x', so you can do something simple, such as:

```
D[cos[x] + x^2, x]
```

which will obtain the solution `-sin[x] + 2x`. Or you can try something a little harder, such as:

```
D[tan^-1[x^x],x]
```

You can also find the (lengthy) second and third derivatives of this function using:

```
D[tan^-1[x^x],{x,2}]
```

and then:

```
D[tan^-1[x^x],{x,3}]
```

You can also use the `D[ ]` function to do partial derivatives, or even implicit differentiation:

```
D[x^2 + (y[x])^3,x]
```

Students often find integration harder than differentiation and, for many years now, have been using the online integrator at **integrals.wolfram.com** to do their homework. As you would expect, Mathematica can symbolically integrate pretty much any function where this makes sense (there are exceptions – such as things like x^x, whose integral has no symbolic representation). However, all the elementary functions are handled as you would expect:

```
Integrate[x^2,x]
Integrate[sin^-1[x],x]
Integrate[log[x],x]
```

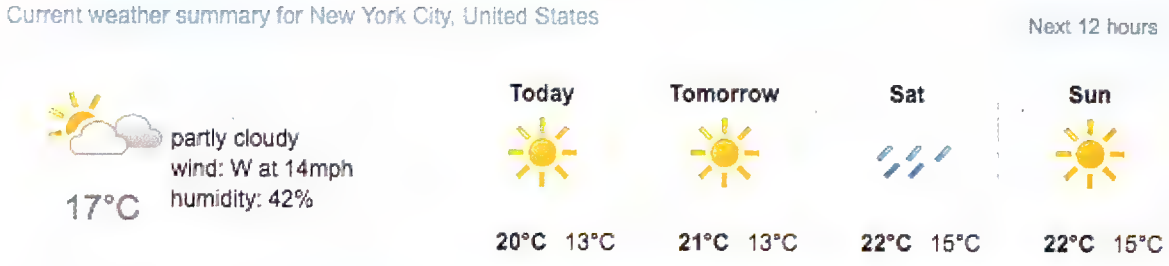
Calculate in the cloud

If the things you want to compute start grinding your Raspberry Pi to a halt or saturating its memory, then it's possible to send certain queries to the Wolfram Alpha knowledge engine to help solve this issue. Where possible, the responses are sent back in a form that you can continue to work with in Mathematica. Naturally, this requires your Raspberry Pi to be connected to the web.

Wolfram Alpha is capable of understanding natural language queries, as well as those in the Wolfram Language (for example, Mathematica input), so you can ask it about anything you like. For example, rather than risk looking out of the window to see external conditions, we can simply type:

```
WolframAlpha["weather new york us"]
```

Bear in mind that there's a limit to how much free compute time you're allowed, so you won't be able to calculate the answer to life. But the cloud technique is still useful for calculations that intermediately use a lot of memory, but return an easy-to-swallow answer.



Remember, don't forget the constant of integration. Furthermore, you can even get complicated expressions for things that don't integrate so nicely. For example,

```
Integrate[ln[cos[x]]]
```

evaluates to a rather ugly complex expression involving polylogarithmic functions. One of Mathematica's most impressive capabilities is its ability to produce graphics. Graphs, surfaces, networks and maps are all just a couple of lines away. We can plot a period of the sine function with a simple:

```
Plot[Sin[x],{x,0,2 * Pi}]
```

TRACK THE WEATHER

You can also make nice weather charts with Mathematica's built-in `WeatherData[]` function. For example, to plot the daily mean temperatures for the summer:

```
DateListPlot[WeatherData
["New York (United States)","
 MeanTemperature",{{2016,6,1},
{2016,9,1},"Day"},Joined
 ->True]
```

We can even venture into three dimensions, and plot the following function [**Image C**]:

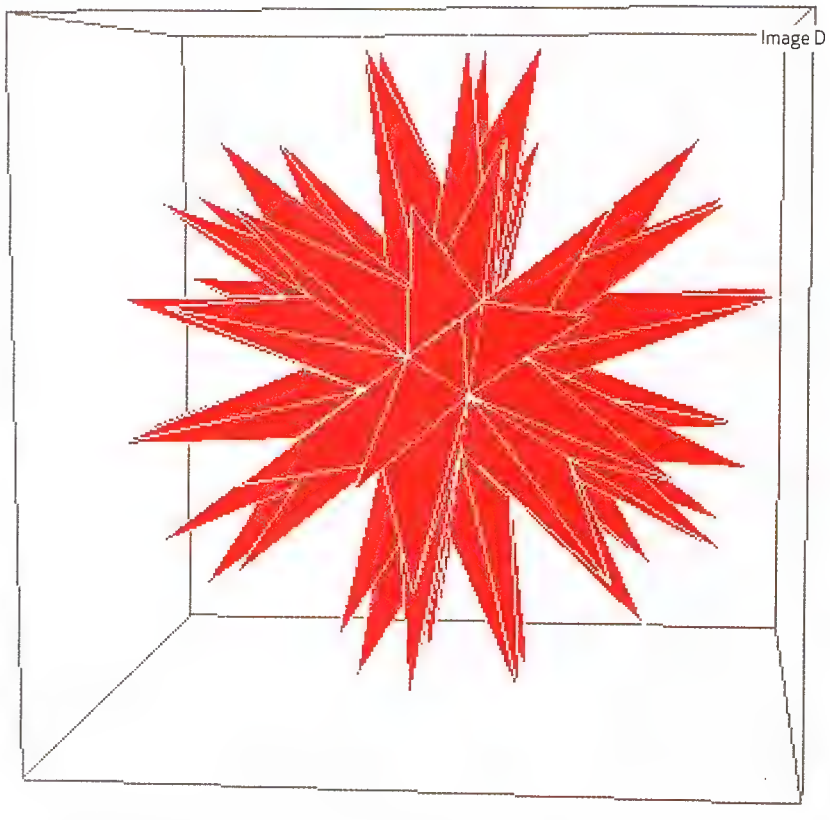
```
Plot3D[Sin[x]+Cos[y],{x,0,2
* Pi},{y,0,2*Pi}]
```

You can draw two (or more) lines or surfaces on the same plot by adding them to the relevant `Plot` function. For example, if you need reminding about how the sine and cosine functions are related:

```
Plot[Sin[x],Cos[x],{x,0,2 *
Pi}]
```

Shapes are easy too, thanks to Mathematica's extensive library of polyhedra. For exampe, to draw a red echidnahedron [**Image D**], use:

```
Graphics3D[{Opacity[.8],
Glow[RGBColor[1,0,0]],
 EdgeForm[White], Lighting ->
None,
   PolyhedronData
["Echidnahedron", "Faces"]}]
```



(And if you've never heard of an echidnahedron, it's an icosahedron stellation having 92 vertices, 270 edges and 180 faces – of course!)

RASPBERRY SPECIAL

For the most part, the Raspberry Pi edition of Mathematica is a diet version of the full-fat product. However, it does have a number of features that are exclusive to this version, namely the ability to talk to devices connected via the GPIO pins, and the CSR-connected PiCam module. All of this invocation happens through the `DeviceRead` and `DeviceWrite` commands. For example, to set pin 14 to high:

```
DeviceWrite["GPIO", 14 -> 1]
```

Replace '1' with '0' to set it to low. To read the status of GPIO pin 14 (GPIO14 in the BCM numbering – take care), do:

```
status = DeviceRead["GPIO", 14]
```

and the variable status will take on the value '0' or '1', as appropriate. You can import an image from the camera module into Mathematica as follows:

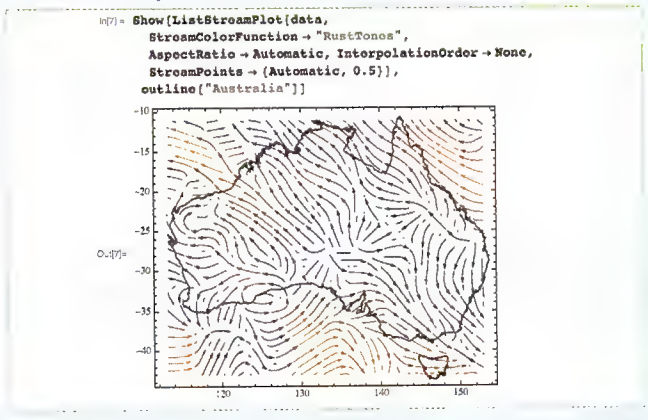
```
img = DeviceRead["RaspiCam"]
```

And then you can export it as a JPEG, or whatever format you like, using the following:

```
Export["/home/pi/img.jpg", img]
```

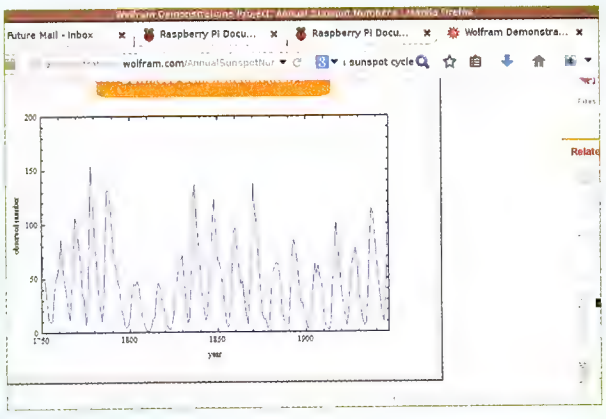
And here, we end our quick journey through the Pi edition of Mathematica.

Things to try with Mathematica



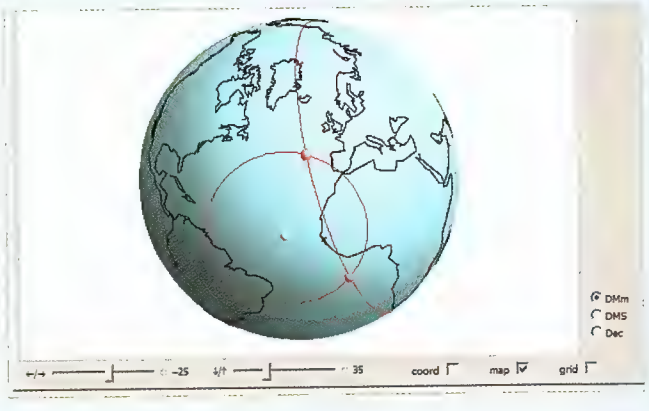
1. Stream plot

Here is a stream plot that shows the directions of wind across Australia. The higher wind speeds are represented by brighter colours. To do this yourself, the outline function needs to be manually entered, but you can find all the details on how to do this on the Wolfram blog. Stream plots are commonly used to visualise differential equations (**bit.ly/WeatherPatterns**).



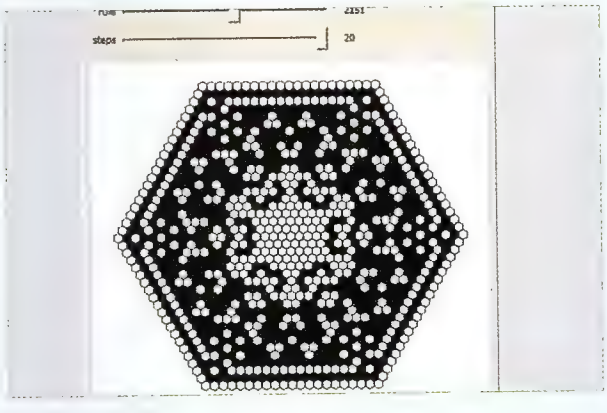
2. Sunspot Cycle

Witness the 11-year sunspot cycle, using publicly available data. Between 1640 and 1710, there were abnormally few sunspots, which coincided with the European 'mini ice age'. In general, if you're looking for frequencies in noisy data, a good trick is to convolve your data with a moving average kernel, to smooth it out before using Fourier analysis (**bit.ly/SunspotNumbers**).



3. Celestial Navigation

An old Maori proverb says, "Before you embark on a journey, make sure you know the stars." Here, you can get your bearings by measuring the angles of altitude to planets, stars or the moon at a specific time. The celestial sphere is approximated by Earth moving through a circular orbit at constant speed, otherwise things get ugly (**bit.ly/CelestialNavigation**).



4. Snowflakes

Cold outside? Have a play with some different kinds of snowflakes. This one is generated using hexagonal cellular automata. All snowflakes exhibit hexagonal symmetry, due to hydrogen bonding in water molecules. When they freeze, the crystals are formed into a hexagonal arrangement, because of the layout of the charges (**bit.ly/SnowflakeLikePatterns**).

The *other* $35 mini-computer

The Raspberry Pi isn't the only quad-core mini-computer you can pick up for under $100. Darren Yates explains how he made his own for just $35.

The Raspberry Pi has been able to do what few PC brands have managed over much of the last five years and that's get people interested in PCs again. Some might baulk at calling the Raspberry Pi a 'personal computer', but this tiny single-board computer has matured over the last year or so to pack a surprising performance punch. Still, it's far from the only option available.

Long before Intel launched its Compute Stick or ASUS got busy with Chromebit, one of the most interesting sideshows in the Android carnival has been the rise of mini-PCs, these often tiny USB stick-style computers with an HDMI connector on one end and a USB port on the other. We've been looking at them since 2012, starting with the original MK802, and in that time, they've generally shown the Raspberry Pi a clean pair of heels in terms of performance. But this year, the Raspberry Pi 3 has roared back, with its quad-core CPU and new built-in wireless networking. While it's still nominally priced at US$35, the Pi 3 Model B has to battle the Aussie dollar, GST and whatever else before landing here in Australia for about $70.

However, for around the same price, you'll find a number of Pi alternatives that feature either dual- or quad-core CPU, 802.11n Wi-Fi, Bluetooth 4.0, even a touchscreen and built-in battery power.

THINK OUTSIDE THE BOX

Shop around and you could find some of these Pi 3 alternatives for under $40, which is exactly what we did, purchasing one for this story. Now by a strange coincidence, our $34.50 single-board quad-core computer looks a lot like a smartphone – okay, so it is a smartphone – but before you burn the magazine in disgust, put the pitchfork down and let me explain.

It's all about thinking outside the box – you may well see an Alcatel Pixi 3 (4.5) prepaid smartphone I picked up from my local Coles supermarket for $34.50. But I see a quad-core processor, 1GB of RAM, 4GB of flash expandable to 32GB, 802.11n Wi-Fi, Bluetooth 4.0, 5MP camera, touchscreen, removable battery and Android 5.1 'Lollipop' operating system. As smartphones go, it'd be fair to say few will ever confuse the Pixi 3 (4.5) with a Galaxy S7 Edge – the Pixi 3 won't make our 'top five phone screens' list, for a start. But really, who cares? It's a $34.50 portable computer and the Pixi 3 (4.5) isn't the only option.

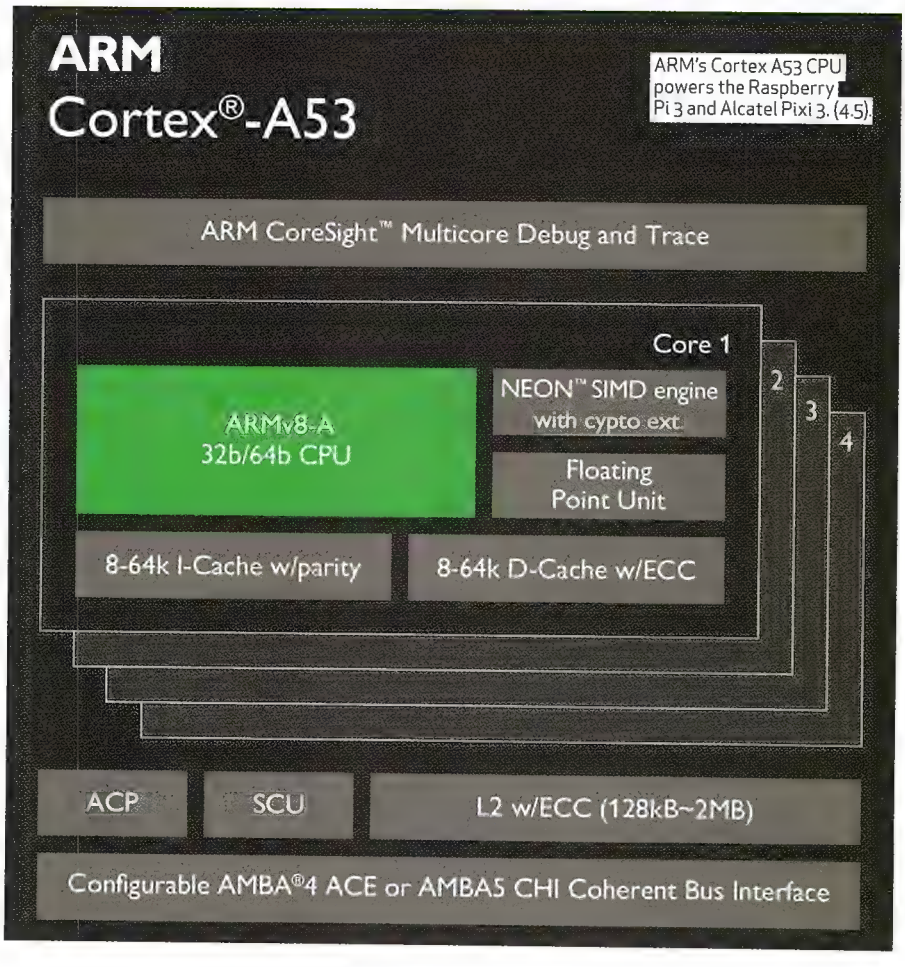
The continued fall in Android-grade hardware costs has seen a similar fall occur in entry-level Android phone prices. Telstra has sold a couple of rebadged ZTE models in the Tempo and the new Smart Plus, the Tempo selling for as little as $29. Optus has the smaller 3.5-inch Pixi 3 for $49 and the ZTE quad-core/4G-equipped ZIP for $69, not to mention the Pixi 3 (4.5) itself, which has sold at retail for anywhere between $29 and $69.

Now don't get me wrong – we're not saying toss out your Raspberry Pi boards and go buy cheap smartphones. We're simply saying 'think outside the box' – if you have an application where a battery-powered ARM-class mini-computer would work, could a super-cheap prepaid smartphone be worth a look?

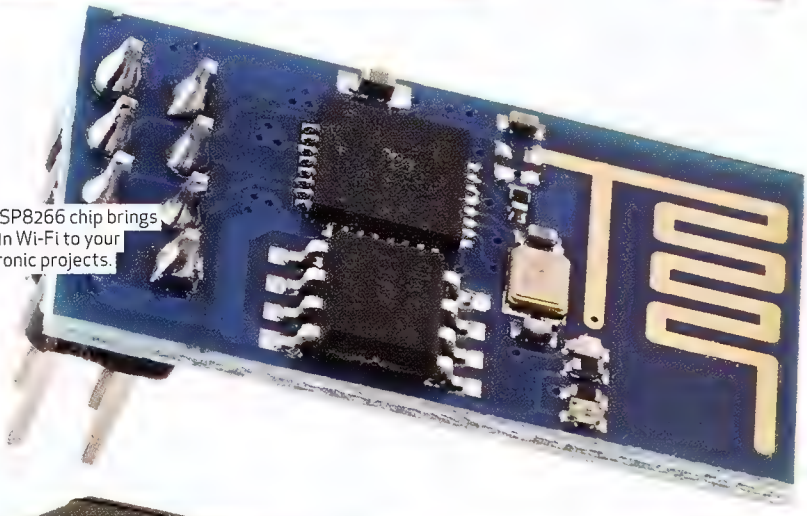
COMPARING THE SPECS

Some readers will no doubt hyperventilate that I dare blaspheme against the Raspberry Pi, but a quick look at the specs of the Raspberry Pi 3 Model B and Alcatel's Pixi 3 (4.5) reveal that, despite their obvious differences,

> "Now don't get me wrong – we're not saying toss out your Raspberry Pi boards and go buy cheap smartphones."



This $7 Bluetooth module can connect your projects to your phone.



The ESP8266 chip brings 802.11n Wi-Fi to your electronic projects.

The MK802, one of the first Android mini-PCs from 2012.

they actually have a fair amount in common, as you'll see in the table.

Let's start at price. As we mentioned earlier, the Raspberry Pi 3 Model B lands in Australia for roughly $70. It's basically the same price of the Pixi 3 (4.5) around the country, although Optus has aggressively pushed its version through Coles supermarkets for as little as $34.50 (where we picked up ours).

Now take a look at the SoC – the 'System on a Chip' – powering these two devices. The Pi 3 runs Broadcom's new BCM2837 and the Pixi 3 (4.5), MediaTek's equally-fresh MT6735M. But here's the thing: underneath, both of these SoCs run exactly the same processor tech in ARM's 64-bit quad-core Cortex A53. The only difference is that the Pi 3 Model B clocks in at 1.2GHz whereas the Pixi 3 (4.5) tops out at 1.1GHz. So, bottom line, these two devices actually share a common heritage! As for graphics engine, the BCM2837 packs in a dual-core VideoCore IV GPU setup, the MT6735M runs two Mali-T720 cores.

In addition, both devices feature 1GB of RAM, and while the Pi 3 comes with no internal flash storage (the Pixi 3 has 4GB), both will run a 32GB MicroSD card in a removable slot. They also both have Bluetooth 4.0 and 802.11n Wi-Fi.

DIFFERENCES

Now for the differences. For built-in direct-connect peripheral ports, the Pi 3 is obviously a clear winner with four USB2.0 ports, HDMI output, composite video output, Ethernet and GPIO bus are hard to beat. However, the Pixi 3 (4.5) comes with a built-in screen, removable battery, 5MP camera sensor and 4G-LTE network connectivity, things you have to pay extra for on the Pi 3. The one thing of note the Pixi 3 (4.5) does lack – and it's a crying shame – is USB-OTG. Unfortunately, the MicroUSB port is just a charging and peripheral port – it doesn't have host capabilities, so that means no external USB devices or storage. Still, don't miss the wood for the trees – it's the differences that make these devices suitable for different applications. In fact, let's take a look at a few.

1 LEARNING TO CODE

While an untold number of Raspberry Pi boards have found homes at the centre of cheap home theatre systems, the Pi's original goal was to provide a low-cost way to learn to code. It's a fantastic goal and we're all for it – but it's not the only way to learn. A budget Android smartphone can definitely fill this role – grab a PC, download Android Studio 2.1, plug in your smartphone and you can learn to code your own Java/Android apps, sideload them onto your device or upload them to the Google Play store.

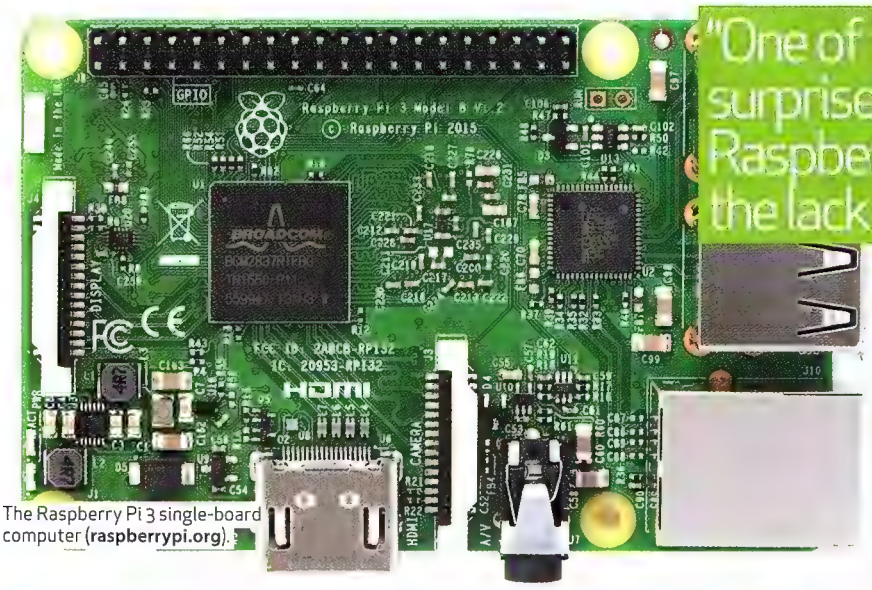
Sure, needing an extra computer kind-of defeats the purpose somewhat, but the Pi itself also needs extras in a display device, keyboard and mouse. On the other hand, grab a Bluetooth keyboard, pair it up to your phone and you can learn to code Python on the spot. Google Play has Python 2 and 3 freely available with integrated development environments or IDEs ready to roll.

2 GPIO

One of the Pi's less-secret weapons is its GPIO bus – the set of General Purpose Input Output pin connections. Not only does the Pi allow you to make your own computer for not very much, you can plug in your own electronic components and circuits, turning the Pi into everything from robots to stratospheric travellers.

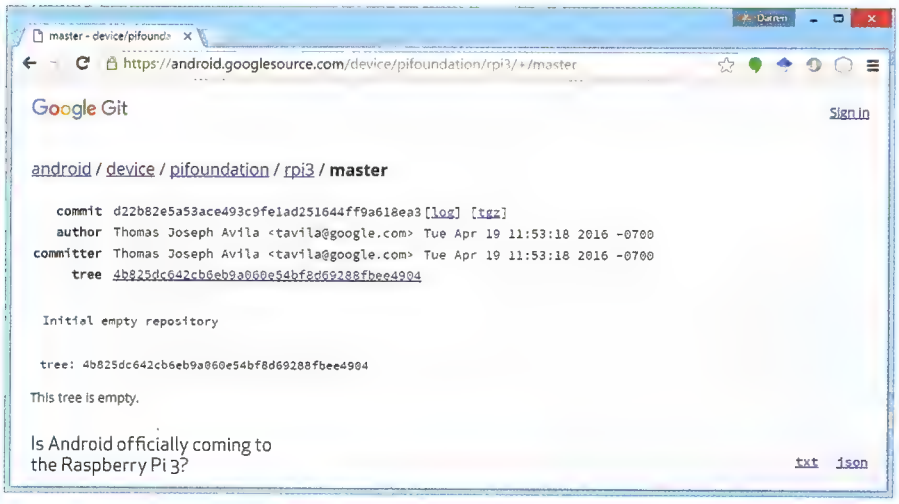
Can't do that with a cheap phone? Let's see about that. With Bluetooth 4.0 and 802.11b/g/n Wi-Fi, even the Alcatel Pixi 3 (4.5) has options to hook up your own electronic circuits. Putting on my Arduino Masterclass hat for a moment, we've already looked at a couple of them. The HC-05 is a popular low-cost Bluetooth module that allows your electronics to talk to other Bluetooth-enabled devices, including your Android phone. Then there's the ESP8266, the revolutionary low-cost chip available in a $3 module that adds 802.11n Wi-Fi to any Arduino project.

While the GPIO bus gives you access to digital I/O lines on the Pi's CPU, it still requires external electronics to handle even modest tasks. For example, those I/O lines can only handle low-power loads, so direct-connection of motors or similar components just isn't an option without output driver transistors or power modules. The Pi 3 also lacks an



The Raspberry Pi 3 single-board computer (**raspberrypi.org**).

"One of the things that always surprised us about the Raspberry Pi has been the lack of Android support."


master - device/pifound
https://android.googlesource.com/device/pifoundation/rpi3/+/master
Google Git
Sign in
android / device / pifoundation / rpi3 / master
commit d22b82e5a53ace493c9fe1ad251644ff9a618ea3 [log] [tgz]
author Thomas Joseph Avila <tavila@google.com> Tue Apr 19 11:53:18 2016 -0700
committer Thomas Joseph Avila <tavila@google.com> Tue Apr 19 11:53:18 2016 -0700
tree 4b825dc642cb6eb9a060e54bf8d69288fbee4904
Initial empty repository
tree: 4b825dc642cb6eb9a060e54bf8d69288fbee4904
This tree is empty.
txt json
Is Android officially coming to the Raspberry Pi 3?

Our Raspberry Pi 3 alternative just happens to look like an Alcatel Pixi 3.

Telstra's $69 Tempo smartphone has sold for as little as $29.

analog-to-digital converter (ADC) on-board, but this can be added cheaply with a $5 Arduino board and its built-in 10-bit ADC. Further, plug in that HC-05 Bluetooth module into the Arduino board and you can have it working wirelessly on a smartphone or Pi 3.

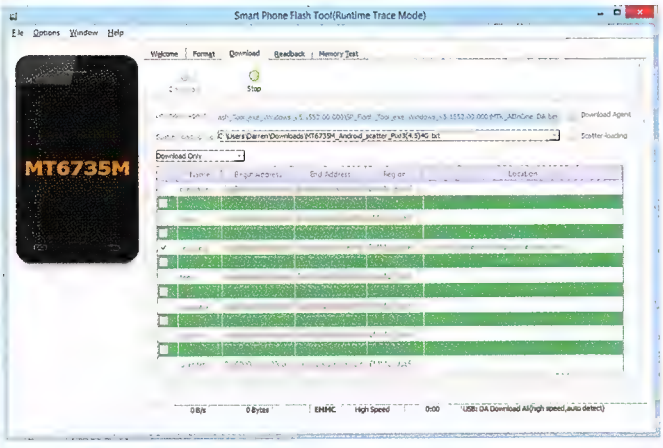
3 MULTIMEDIA

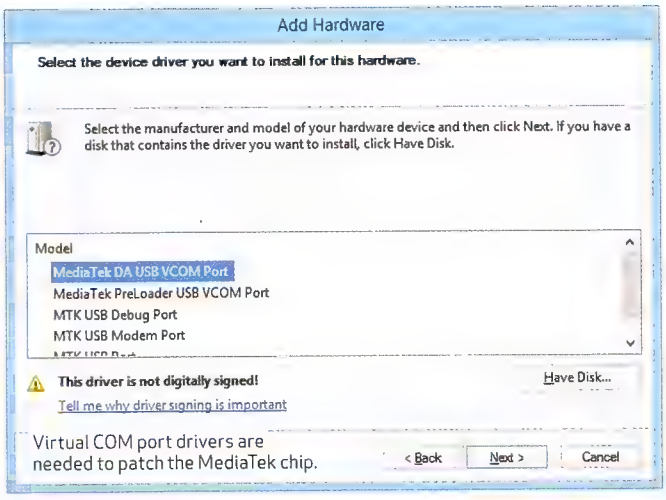
Given many Raspberry Pi boards have ended up powering home theatre systems, it'd be wrong not to also consider the multimedia capabilities from an Android mini-PC perspective. To be fair, the lack of HDMI on a budget smartphone definitely limits the appeal in that regard. But having a built-in screen and battery gives it other options the Pi 3 doesn't have.

Unfortunately, the Alcatel Pixi 3 (4.5) also lacks built-in Miracast or 'screen casting', meaning you can't transmit the screen contents over Wi-Fi to another display device. However, it has one saving grace – and that is it works happily with a Chromecast dongle. Use the phone as a remote control and you can access your own media content or head online and watch YouTube, Netflix or Stan movies and TV shows. And of course, you can always watch your own content – whether stored locally or on your own home network – on the device screen itself.

4 ROOT ACCESS

One of the things that always surprised us about the Raspberry Pi has been the lack of Android support. Not long after the original launch, an effort began in porting Android 4.0 to the first-gen Pi, there were even a couple of screenshots floating around. But unfortunately, that's as far as it got, as support for Linux distros, in particular the brilliant 'Raspbian', took off. However, one of the more interesting rumours doing the rounds recently is that an official Android could soon be coming to the Raspberry Pi 3. Google has indeed added the latest Pi 3 board as a new device tree in the Android Open Source Project (AOSP) repository (**tinyurl.com/apc432andpi**), but at time of writing, the tree folder was as empty as a pub with no beer. Given it was Google's Eric Schmidt who gave the Raspberry Pi Foundation's




Add Hardware
Select the device driver you want to install for this hardware.
Select the manufacturer and model of your hardware device and then click Next. If you have a disk that contains the driver you want to install, click Have Disk.
Model
MediaTek DA USB VCOM Port
MediaTek PreLoader USB VCOM Port
MTK USB Debug Port
MTK USB Modem Port
This driver is not digitally signed!
Tell me why driver signing is important
Have Disk...
Virtual COM port drivers are needed to patch the MediaTek chip.
< Back
Next >
Cancel

The Pixi 3 (4.5) can be rooted using the Smart Phone Flash Tool.

Eben Upton the nudge to launch the US$5 Raspberry Pi Zero, an Android distro for the Pi 3 wouldn't surprise.

In the meantime, the first thing we'd suggest doing with any Android mini-computer, provided you don't mind some risk and losing your warranty, is gaining root access. That said, doing so on the Alcatel Pixi 3 (4.5) requires not the most-complex process ever devised, but we reckon it wouldn't be far off!

The process is outlined over at XDA Developers and isn't without risk, but here it is in a nutshell: first, you need special VCOM preloader drivers for the MediaTek MT6735M CPU – the drivers aren't signed so installing on anything 64-bit after Windows 7 is a pain. You also need the MediaTek SP Flash Tool to flash the new Recovery ROM to the device. Next, you need an actual Recovery ROM. TeamWin Recovery Project (TWRP) is recommended, but don't use the new 3.0.0-0 release – it doesn't work on the Pixi 3 (4.5). Get the 'TWRPRecovery4G' ROM and full details from **tinyurl.com/apc431-twrp** listed in Point 5 on the webpage. You also need SuperSU from XDA guru Chainfire. Stick all of it in a blender and, eventually, you'll get root access.

6 32GB WIRELESS SERVER

The benefit of having root access is that you gain full control of your device, rather than just the bits of the Android operating system Google would prefer you stick to. In fact, one of the things you can do with root access is to turn your Android device into an emergency wireless file server. We've looked at this a couple of times previously, so just briefly, you can turn a rooted Pixi 3 (4.5) into a 32GB wireless file server, accessible from any device on your home network. All you need is to purchase and install SambaDroid Pro from Google Play (there is a free version to try out first). You can set password and folder restrictions – and it's more than fast enough to stream video files. Most NAS boxes have less CPU power than you'll find inside the Pixi 3 (4.5) anyway.

> "You could start by learning about the $5 Arduino, then the components behind Arduino-like boards."

THERE'S MORE BEYOND THE BOX

As we've said before, the Raspberry Pi concept is brilliant as a stepping stone into a larger world of technology. But it'd be a shame if the Raspberry Pi was as far as you got. The world of electronics (and we're talking right up to computers and smartphones) is jam-packed with millions of different options for doing almost anything.

You could start by learning about the $5 Arduino, then the components behind Arduino-like boards – microcontrollers from Atmel and Microchip, among others. Delve down into the microcontroller chips themselves and learn how different types of transistors work, from common bipolar-junction transistors or BJTs to metal-oxide silicon field-effect transistors or MOSFETs.

The Raspberry Pi is a brilliant tool for learning – no question. But as the cost of computing in all its forms continues to fall, the Pi isn't the only low-cost computer going around. You might just find an alternative at your local supermarket. ■

MINI PCs COMPARED

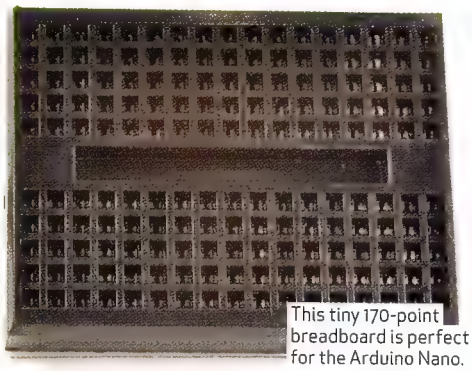
	RASPBERRY PI 3 MODEL B	ALCATEL PIXI 3 (4.5)
PRICE (AUD)	$69	$69
SOC	BROADCOM BCM2837	MEDIATEK MT6735M
PROCESSOR	1.2GHZ QUAD-CORE ARM CORTEX A53	1.1GHZ QUAD-CORE ARM CORTEX A53
GPU	BROADCOM VIDEOCORE IV	ARM MALI-T720MP2
RAM	1GB	1GB
OPERATING SYSTEM	LINUX-BASED (RASPBIAN ETC.)	ANDROID 5.1 (LOLLIPOP)
INTERNAL STORAGE	NONE	4GB
EXTERNAL STORAGE	UP TO 32GB MICROSDHC	UP TO 32GB MICROSDHC
LCD PANEL	NONE	4.5-INCH (854 X 480 PIXELS)
BATTERY	NONE	1780MAH LI-ION (REMOVABLE)
PERIPHERALS		
ETHERNET	10/100 FAST ETHERNET	NONE
WI-FI	802.11N	802.11N
BLUETOOTH	BLUETOOTH 4.0	BLUETOOTH 4.0
GPIO	17 X DIGITAL I/O	NONE
HDMI	HDMI V1.3	NONE
USB HOST	4 X USB2.0	NONE
CAMERA	NONE (8MP OPTIONAL)	5MP SENSOR (BUILT-IN)

Build an ultrasonic tape measure with an Arduino

Darren Yates puts together a tiny ultrasonic tape measure with OLED screen and warning buzzer powered by the tiny Arduino Nano.

Shrinking the size of Arduino projects is often difficult to do when you stick with the standard Arduino form factor. However, the combination of low-cost Arduino Nano microcontroller board and equally tiny 170-tiepoint breadboard can make it easier than you think.

After our tiny weatherstation last month, this month, we've put together a simple ultrasonic tape measure with an OLED panel showing distance in centimetres, plus a minimum-distance threshold warning buzzer.



This tiny 170-point breadboard is perfect for the Arduino Nano.

HOW IT WORKS

The heavy lifting for this project is carried out by an HC-SR04 ultrasonic sensor. You'll find these things everywhere online – we've used this device previously as the 'eyes' for a number of robots. It's a cheap and (reasonably) accurate measurement device, sending out ultrasonic 40kHz pulses and tracking the time it takes for the pulse reflections to return. Since the speed of sound in open air is well known (343.2 metres per second), halve the return time and you can calculate the distance travelled.

The SR-04 sensor is plugged into the very end row of the breadboard corresponding to the Arduino Nano's digital I/O pins D3 to D6. Because of the way the SR-04's pins are arranged, it sits nicely in position, transducers facing outwards. In a happy coincidence, it's also almost exactly the same length as the breadboard, which makes it look like it was designed that way.

We've also added a 5-volt piezo buzzer between pins D13 and A0. The reason we've used these particular pins is that the buzzer slots into position here without requiring any jumper wires or links, nor does it get in the way of something else. And as with last month's project, we've included a tiny 0.96-inch 128 x 64-pixel OLED panel, plugged into the analog pins A4 to A7.

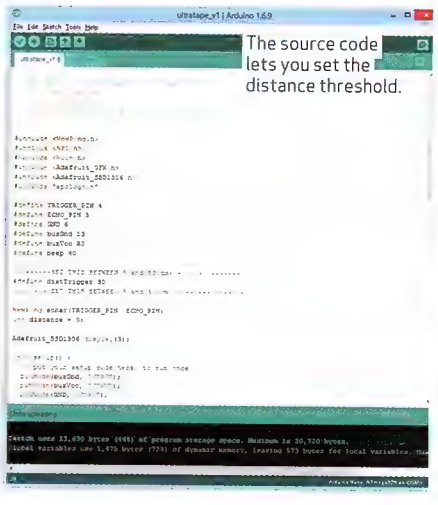
The project can also double as a simple door-minder if you're happy to ditch the OLED panel – the tiny 5-volt piezo buzzer chirps whenever the distance to an object in front of the ultrasonic sensor drops below a presettable level.

POWER TRICKS

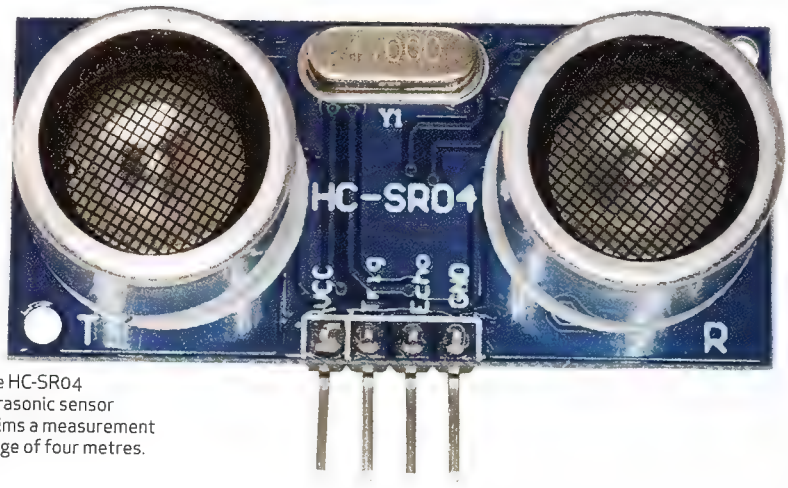
The trick with this project is how we power everything. Overall power is supplied through the Arduino Nano's USB port. We recommend a USB power pack to make the whole thing more portable, but it can also be powered by a USB phone charger or a standard USB port on a PC or laptop (power consumption should be no more than 50mA).

The ultrasonic sensor needs power on its Vcc (5V) and GND (0V) pins. Now previously, we've used the technique of supplying power through the Arduino Nano's digital I/O pins. Unfortunately, the SR-04 sensor needs a little more peak juice than the D3 pin can provide. So instead, we add a single wire connecting D3 to the 5V rail.

The OLED panel requires data transfer using the I2C bus, which exists on the Nano's A4 and A5 pins.

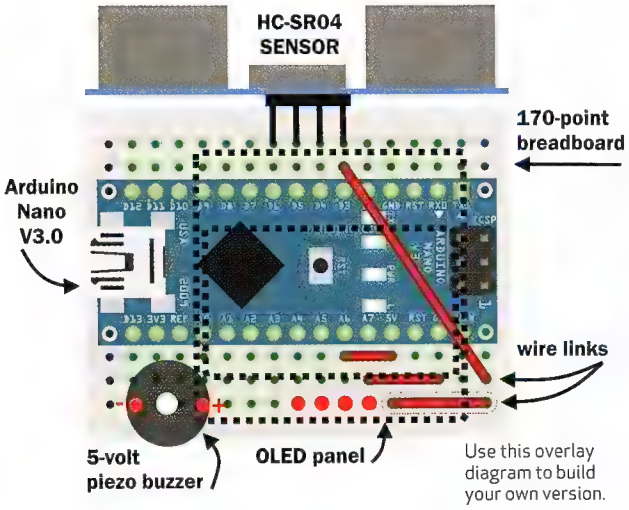


The source code lets you set the distance threshold.

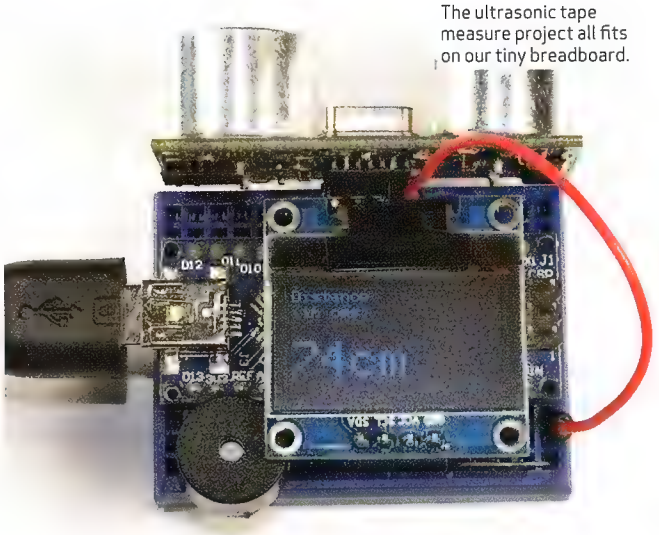


The HC-SR04 ultrasonic sensor claims a measurement range of four metres.

Ultrasonic Tape Measure/Door Minder



Use this overlay diagram to build your own version.

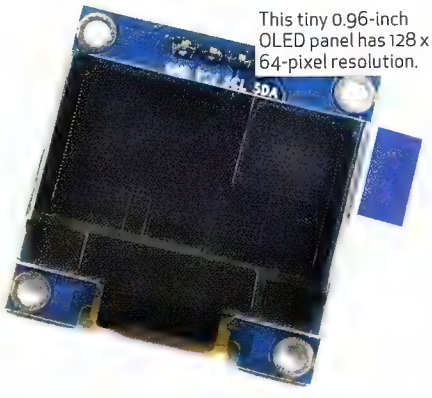


The ultrasonic tape measure project all fits on our tiny breadboard.

The A6 and A7 pins also connect to the OLED panel's power pins, but because these pins on the Nano are inputs only, we need to route power (5V and GND) to them separately from the appropriate power pins nearby using wire links.

Finally, to make the buzzer work, we configure A0 and D13 as outputs with both set to 0V (GND). Pulling the A0 pin to digital-high (5V) creates a current-flow, firing up the buzzer and making it sound. Switching it on and off at an appropriate rate makes the buzzer chirp.

Now some readers may be wondering how we can do all this without blowing up some of the pins on the Arduino Nano. It works on two principles – first, at no point do any digital I/O pins have to source or sink more current than they're rated for; and second, all digital I/O lines are automatically initialised as inputs. This is key, for as inputs, these pins have a very high resistance or 'impedance', which means we can connect power directly to them and power something else, yet the Arduino Nano pins themselves remain unaffected.



This tiny 0.96-inch OLED panel has 128 x 64-pixel resolution.

HOW ACCURATE IS IT?

The SR-04 sensor has a range of approximately four metres and claims it is accurate to within three millimetres. We've taken a conservative approach, showing the results on the OLED panel in centimetres only. We wouldn't use this to fix the foundations of your new home or anything like that, but it will give you an idea of how ultrasonic sensors work and how you can interact with them using an Arduino microcontroller.

MAKING A DOOR MINDER

Turning the ultrasonic tape measure into a door minder is pretty simple – just remove the OLED panel and add that 5-volt piezo buzzer to the specified pins. If the ultrasonic sensor detects a change of distance below a preset point (as in when someone walks through a doorway), the buzzer will briefly chirp. You can change the distance threshold, as well as the tone type coming from the buzzer, within the source code itself.

GETTING THE CODE

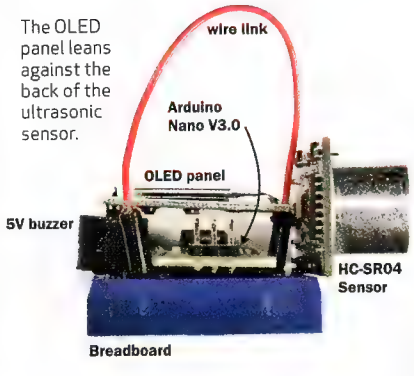
You'll find the code for this project on our website at **apcmag.com.au/magstuff**. Download and unzip the zip file, copy the contents of the libraries subfolder into the same of your Arduino IDE. Don't have the IDE? Head to **arduino.cc/downloads** and grab the latest version for your particular operating system and install it. Next, load the 'ultratape.ino' file into the Arduino IDE, compile and flash the code to your Arduino Nano, build the project by following the overlay diagram, power it up and away you go.

MODIFYING THE CODE

To set the distance threshold for the door-minder, you'll see the code line comments early on in the source code – simply set the code line parameter between 5 and 50 (you should be able to go a bit higher than that but your mileage may vary) and reflash the code to your Arduino Nano.

Of course, you can modify the code as you wish – just be aware that digital pin D3 (connected to the SR-04 sensor's Vcc pin) is not mentioned in the source code because we want it to stay as an input, since we're supplying power directly to it from the Arduino Nano's 5V rail to power the sensor.

The great thing about microcontrollers and electronics in general is that there's usually a thousand different ways to do something. What can you come up with? ■



The OLED panel leans against the back of the ultrasonic sensor.

Learn to code Python — Part 1

Learning to code is one of the great tech things to do. Join Darren Yates each month as he begins this new series on learning to code in Python.

With the end of Australia's mining boom, the future of jobs has turned toward technology and the looming 'digital disruption' threatening to overtake half of all jobs over the next ten years. As technology worms its way into every field of endeavour, knowing how to program or 'code' will become a must-have skill for many careers.

But what's great about coding is that it's never too late to learn – even if you've never coded anything in your life. Learning to code can teach you problem-solving skills and help you better understand how computers work. So starting this month, we're diving into the Python programming language and learning how to code it from scratch. Why Python? Python is a hugely popular language used in many different domains from web development to data science and machine learning. It's free and it's easy to learn, thanks to its simple format or 'syntax'. I'm not into things unless they're practical, so we'll have lots of coding and you'll find the source code each month from our website at **apcmag.com/magstuff**. And it all starts now.

GETTING STARTED

Python runs on almost any device – there are versions for Windows, Mac OS X, Linux, even Android. It comes in two main releases, version 2.7 and the current 3.5. We'll use the latest version 3.5.*x* and assume you have a Windows-based computer. The source code we create each month should work on any device, but we'll only guarantee it tested on Windows systems. Grab the latest version (3.5.1 at time of writing) from **www.python.org/downloads** and install it. Once it's installed, launch the IDLE (integrated development and learning environment) app and you'll get the interactive Shell appear. It's 'interactive' because you can run code straight away without having to first create a separate file. Let's try it. In the Shell window, type the following at the '>>>' prompt:

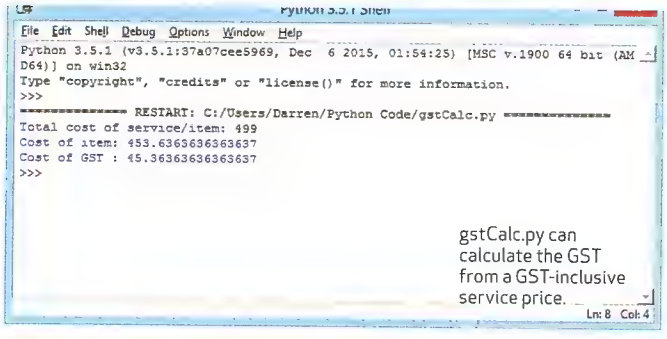
```
print("Hello world, from APC")
```

Press the Enter key and it should display 'Hello world, from APC' straight underneath.

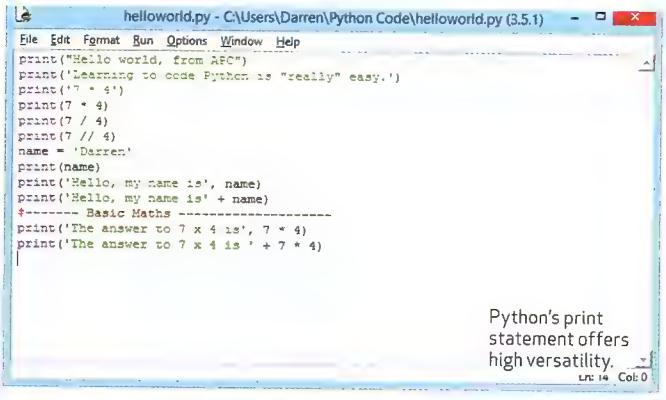
LOAD, SAVE FILES

However, the more practical way to use Python is to write your code in a separate file, save it and have Python run that file. Launch IDLE and from the menu, choose 'File > New File'. This launches a new blank editor window, ready to code. Let's type in that print line again. When you're done, press Control-S or go to 'File > Save'. Choose a filename ('helloworld' is fine) and press the Save button. Go back to the editor window and you should now see 'helloworld.py' at the top (all Python files are saved with the '.py' extension).

You can also load Python programs by selecting 'File > Open' or just pressing Control-O and selecting the file you want to load. When you're ready, select 'Run > Run Module' from the menu or just press the function-key F5. This brings the Python Shell to the foreground and runs your code. Again, you should see the 'Hello world' greeting, but this time, it's coming

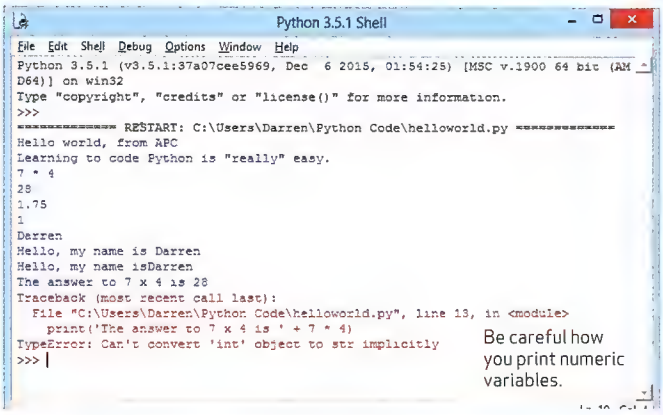

File Edit Shell Debug Options Window Help
Python 3.5.1 (v3.5.1:37a07cee5969, Dec 6 2015, 01:54:25) [MSC v.1900 64 bit (AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
========== RESTART: C:/Users/Darren/Python Code/gstCalc.py ==========
Total cost of service/item: 499
Cost of item: 453.6363636363637
Cost of GST : 45.36363636363637
>>>
Ln: 8 Col: 4

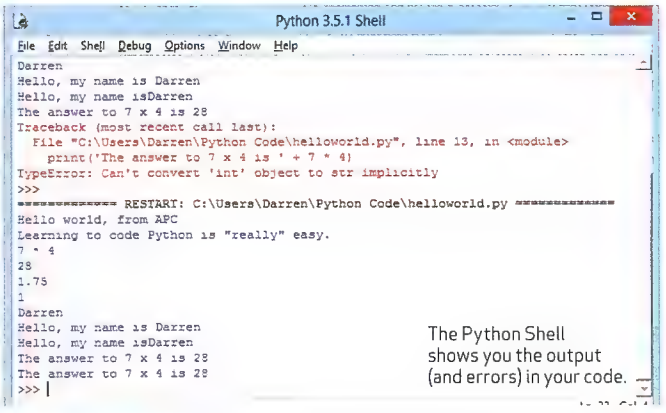
gstCalc.py can calculate the GST from a GST-inclusive service price.

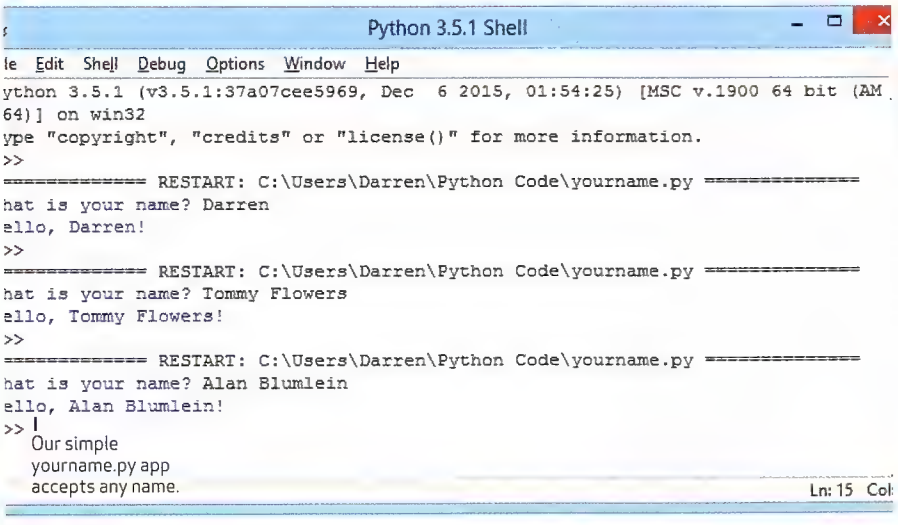

helloworld.py - C:\Users\Darren\Python Code\helloworld.py (3.5.1)
File Edit Format Run Options Window Help
print("Hello world, from APC")
print('Learning to code Python is "really" easy.')
print('7 * 4')
print(7 * 4)
print(7 / 4)
print(7 // 4)
name = 'Darren'
print(name)
print('Hello, my name is', name)
print('Hello, my name is' + name)
#------- Basic Maths --------------------
print('The answer to 7 x 4 is', 7 * 4)
print('The answer to 7 x 4 is ' + 7 * 4)

Python's print statement offers high versatility.

The Python IDLE edit window is simple and easy to use.


Python 3.5.1 Shell
File Edit Shell Debug Options Window Help
Python 3.5.1 (v3.5.1:37a07cee5969, Dec 6 2015, 01:54:25) [MSC v.1900 64 bit (AM
D64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
========== RESTART: C:\Users\Darren\Python Code\helloworld.py ==========
Hello world, from APC
Learning to code Python is "really" easy.
7 * 4
28
1.75
1
Darren
Hello, my name is Darren
Hello, my name isDarren
The answer to 7 x 4 is 28
Traceback (most recent call last):
File "C:\Users\Darren\Python Code\helloworld.py", line 13, in <module>
print('The answer to 7 x 4 is ' + 7 * 4)
TypeError: Can't convert 'int' object to str implicitly
>>>
Be careful how you print numeric variables.


Python 3.5.1 Shell
File Edit Shell Debug Options Window Help
Darren
Hello, my name is Darren
Hello, my name isDarren
The answer to 7 x 4 is 28
Traceback (most recent call last):
File "C:\Users\Darren\Python Code\helloworld.py", line 13, in <module>
print('The answer to 7 x 4 is ' + 7 * 4)
TypeError: Can't convert 'int' object to str implicitly
>>>
========== RESTART: C:\Users\Darren\Python Code\helloworld.py ==========
Hello world, from APC
Learning to code Python is "really" easy.
7 * 4
28
1.75
1
Darren
Hello, my name is Darren
Hello, my name isDarren
The answer to 7 x 4 is 28
The answer to 7 x 4 is 28
>>>
The Python Shell shows you the output (and errors) in your code.


Python 3.5.1 Shell
le Edit Shell Debug Options Window Help
ython 3.5.1 (v3.5.1:37a07cee5969, Dec 6 2015, 01:54:25) [MSC v.1900 64 bit (AM
64)] on win32
ype "copyright", "credits" or "license()" for more information.
>>
========== RESTART: C:\Users\Darren\Python Code\yourname.py ==========
hat is your name? Darren
ello, Darren!
>>
========== RESTART: C:\Users\Darren\Python Code\yourname.py ==========
hat is your name? Tommy Flowers
ello, Tommy Flowers!
>>
========== RESTART: C:\Users\Darren\Python Code\yourname.py ==========
hat is your name? Alan Blumlein
ello, Alan Blumlein!
>>
Our simple yourname.py app accepts any name.
Ln: 15 Col:

from your Python code file. Notice that Python's print command displayed everything within the double quotes ("). But what if you also wanted it to display the double quotes? Easy. Python handles single or double quotes. Open the helloworld.py file again and add the following:

```
print('Learning to code
Python is "really" easy.')
```

Save it (Contorl-S) and run it (F5). Now you can see the word 'really' in double quotes. The trick is to just be consistent – whichever alternate quote type you start the line with, you must finish with.

Now, let's try some basic maths. Underneath the line above, type this:

```
print('7 * 4')
```

Run it again – and we get '7 * 4'? This is a trick for new players – because the numbers are encased in single-quotes, the print statement thinks, 'Okay, print whatever is within the quotes.' Try it again with this new line, save it and hit F5.

```
print(7 * 4)
```

This time we get... 28! The star symbol (*) is the operator for multiplication. Use (+) for addition, (-) for subtraction, (/) for division and (//) for integer-division. Integer-division is where you divide one number by another and if the answer is normally a decimal, you ditch the decimal bit. Type in the following code, save and F5 it.

```
print(7 / 4)
print(7 // 4)
print(-7 // 4)
```

The first line gives '1.75', the second gives '1'. The trick with integer-division, however, is if the result is negative, it's rounded away from zero. That's why the third line gives -2 instead of -1.

VARIABLES

This is great if we know the numbers we want to calculate. They're known as 'literals' because we're typing in the actual numbers into the code. Literals need to be used carefully anyway, but in this case, our code is great if we want to calculate 7 x 4 – pretty useless if we want to calculate anything else.

So how do we fix it? The first step is with 'variables' – a variable is like an empty box you can put stuff in or 'assign' stuff to. Variables are a fundamental part of any programming language, but Python makes them particularly easy to work with. The first thing is to start with a name – every variable has to have a name and it's common sense to name the variable to match the type of data you're putting into it. For example, if you're going to store someone's name, a pretty good name for the variable would be 'name'. Type the following, save and F5 it.

```
name = 'Darren'
print(name)
```

To assign a value to a variable, you use the form 'variable = expression' – here, the expression is the string 'Darren' (it's a string because it's surrounded by single quotes) and with the equals sign, we assign it to a variable called 'name'. By telling Python to print the variable 'name' without quotes, we're saying print whatever is stored in that variable. We can also combine the two. Code the following:

```
print('Hello, my name is',
name)
print('Hello, my name is' +
name)
```

And the output we get is:

```
>Hello, my name is Darren
>Hello, my name isDarren
```

In both print statements, we're doing a thing here called 'string concatenation'. In each case, we have the literal string 'Hello, my name is', along with the 'name' variable holding the string 'Darren' as before. We're joining or 'concatenating' these strings together using two different methods – first, through multiple sections or 'arguments' separated by the comma (,) and second, creating one argument by joining strings with the plus operator (+). They're essentially the same – except for one minor difference. Notice the extra space between 'is' and 'Darren' in that first output line? The default option for printing multiple arguments is to separate them with a space. Concatenation via the plus operator requires you to supply your

own spaces. But if you can use the plus operator for concatenation, what happens if you try to use it for maths at the same time? Let's try it.

```
print('The answer to 7 x 4 is', 7 * 4)
print('The answer to 7 x 4 is ' + 7 * 4)
```

The output is:

```
>The answer to 7 x 4 is 28
>TypeError: can't convert
```

The first codeline works, but the second creates a 'type' error. The comma (,) in the first line separates two arguments and Python understands that you want it to calculate 7 x 4 in the second argument and print the result. When you use the plus operator instead, Python thinks you want to convert the '7' to a string-literal, but then doesn't know what to do with the multiplication symbol (*) because you can't multiply strings. A better way to do this is to calculate the equation, store the result in a variable and print the contents:

```
result = 7 * 4
print('The answer to 7 x 4 is', result)
```

And we get:

```
>The answer to 7 x 4 is 28
```

This is where the 'variable = expression' idea comes in – Python calculates whatever is on the right-hand-side of the equals sign (=) first (called the 'expression'), then assigns the value of that expression to the variable. In our case, it calculates 7 x 4 and stores the result (28) in the variable we've called 'result'. The next line is similar to before and prints the value stored in that 'result' variable.

There are four basic variable types you'll get to know – 'string' for storing characters such as words and text, 'integer' for storing whole numbers, 'floating-point' for decimal numbers and 'boolean' for true/false values.

In many languages, you have to declare the type of variable you're about to use. However, Python is clever enough to work that out itself – you just create a correctly-named variable and assign your value or expression to it.

NAMING VARIABLES

While you have plenty of latitude for naming variables, there are some basic rules you must follow. Variables can only start with characters a-z, A-Z or underscore (_) and you can't use a Python keyword as a variable (a keyword is a word Python already uses, such as 'print'). Variable names also can't contain spaces. It's also a convention to start variables with a lowercase letter and start each subsequent word with a capital, for example 'calculateInterestRate'. It's called 'camel case' because it looks like the humps on a camel. You can opt for variable names as simple as 'x' and 'y', but it's much better to make them something you'll understand. Variable names should be less than 255 characters, but shouldn't require more than three words.

INPUT OUTPUT

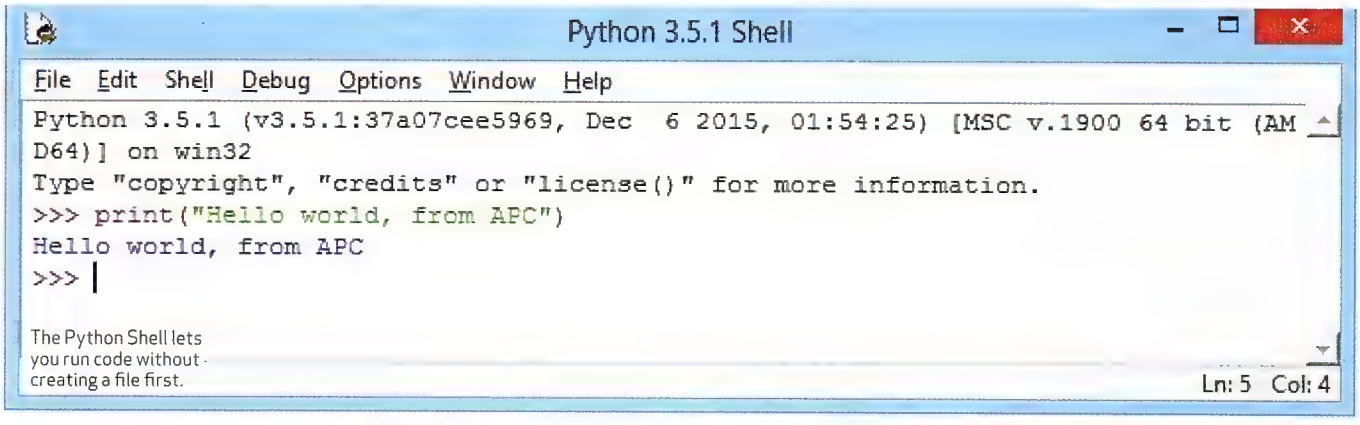
So far, we've looked at printing stuff and creating variables, but for our programs to be really useful, we need to take input from the user. There's a standard programming concept called 'input, process, output' or IPO where you take user input, process the input, then output some result back to the user. So how do we get user input? Create a new program (File > New File), add the following code, save it as 'yourname' and F5 it.

```
name = input('What is your name? ')
greeting = 'Hello, ' + name + '!'
print(greeting)
```

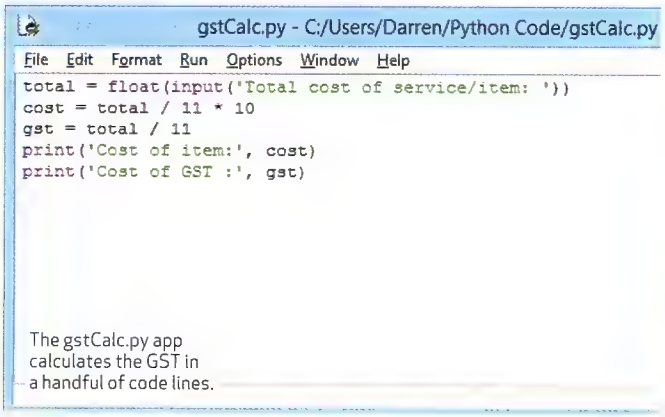
Here's an example output:

```
>>What is your name? Darren
>>Hello, Darren!
```

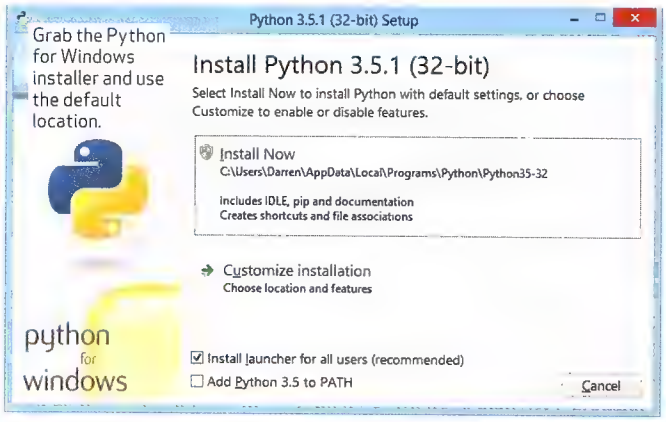
The 'input' command allows your code to accept keyboard input, waiting for the Enter key to be pressed and makes the result ready as a string. You can then assign that string to a


Python 3.5.1 Shell
File Edit Shell Debug Options Window Help
Python 3.5.1 (v3.5.1:37a07cee5969, Dec 6 2015, 01:54:25) [MSC v.1900 64 bit (AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> print("Hello world, from APC")
Hello world, from APC
>>>
Ln: 5 Col: 4

The Python Shell lets you run code without creating a file first.


gstCalc.py - C:/Users/Darren/Python Code/gstCalc.py
File Edit Format Run Options Window Help
total = float(input('Total cost of service/item: '))
cost = total / 11 * 10
gst = total / 11
print('Cost of item:', cost)
print('Cost of GST :', gst)

The gstCalc.py app calculates the GST in a handful of code lines.


Python 3.5.1 (32-bit) Setup
Grab the Python for Windows installer and use the default location.
Install Python 3.5.1 (32-bit)
Select Install Now to install Python with default settings, or choose Customize to enable or disable features.
Install Now
C:\Users\Darren\AppData\Local\Programs\Python\Python35-32
Includes IDLE, pip and documentation
Creates shortcuts and file associations
Customize installation
Choose location and features
python for windows
Install launcher for all users (recommended)
Add Python 3.5 to PATH
Cancel

yourname.py - C:\Users\Darren\Python Code\yourname.py (3.5.1)

File Edit Format Run Options Window Help

```
name = input('What is your name? ')
greeting = 'Hello, ' + name + '!'
print(greeting)
```

The yourname.py app requires just three code lines.

Ln: 1 Col: 0

helloworld.py - C:\Users\Darren\Python Code\helloworld.py (3.5.1)

File Edit Format Run Options Window Help

```
print("Hello world, from APC")
print('Learning to code Python is "really" easy.')
print('7 * 4')
print(7 * 4)
print(7 / 4)
print(7 // 4)
name = 'Darren'
print(name)
print('Hello, my name is', name)
print('Hello, my name is' + name)
#------- Basic Maths --------------------
print('The answer to 7 x 4 is', 7 * 4)
#print('The answer to 7 x 4 is ' + 7 * 4)
#------- Add a variable -----------------
result = 7 * 4
print('The answer to 7 x 4 is', result)
```

Adding a variable to our helloworld.py app is easy.

Ln: 17 Col

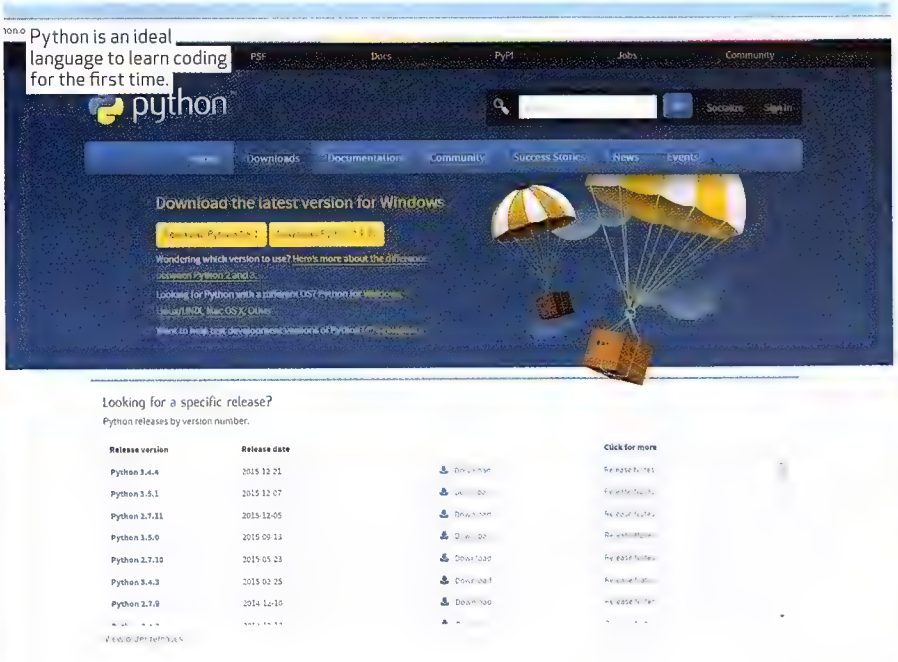
Python 3.5.1 Shell

File Edit Shell Debug Options Window Help

```
Python 3.5.1 (v3.5.1:37a07cee5969, Dec  6 2015, 01:54:25) [MSC v.1900 64 bit (AM
D64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
```

The Python Shell runs code output but also works interactively.

Ln: 3 Col: 4



variable. In our code, we're asking the user 'What is your name?' and storing the result in the variable called 'name'. In the second line, we're creating a simple greeting message that starts with 'hello' and adds the value of the name variable to the end of it, with the result stored in a variable called 'greeting'. The third line prints the value of that 'greeting' variable. The beauty of this is that you can now ask any user their name and give them back a personal greeting with the same code.

Finally, this month, we'll bring it altogether with a GST calculator app. Imagine you've paid for some service or item and you want to know how much of that fee is GST. The Goods & Services Tax in Australia is currently 10%, which means, if we know the total, we divide it by 11 and that's the GST component. How do we code that? Launch a new program called 'gstCalc' and type the following:

```
total = float(input('Total cost of service/item: '))
cost = total / 11 * 10
gst = total / 11
print('Cost of item:', cost)
print('Cost of GST:', gst)
```

Save and F5 it. At the prompt, type in the cost of an item, hit Enter and it'll return the actual cost plus the GST as separate components. The first line here is probably tricky. Note how the 'float' command brackets wrap around the entire 'input' command – this tells Python we want user input, but we want the input string turned into a decimal or 'floating point' number and that number stored in a variable called 'total'. We do this because we cannot perform maths operations on string variables, so by turning it into a floating-point number, the 'total' variable also becomes a floating-point variable.

Now dividing that number by 11 and multiplying by 10 gives us the cost component, dividing the total by 11 gives us the GST component. Store those in variables, 'cost' and 'gst', respectively, and you can print them to the screen.

CONGRATS!

Got this far? Brilliant. If you're stumped on something, just go back and have another crack at it. In the meantime, keep coding – play around with the apps here and see what happens. Try writing your own apps from scratch. And don't worry about making mistakes – mistakes when you're learning to code are important because they teach you what doesn't work. It's much better to learn now than trying to figure out why something didn't work later on.

We'll be back next month with more Python. See you then.

Overwatch is a game about different coloured lights.

$89.95 | PC | WWW.PLAYOVERWATCH.COM

apc HOT PRODUCT

Overwatch

It's bright, colourful and competitive, but is it any good?

Right now, I hate Junkrat. He's a scrawny, impish explosives expert with a grenade lobbing Frag Launcher. His ultimate ability – a slow charging special attack that fills faster as you do damage and score kills – is a motorised, remote control tyre bomb with a devastating area of effect. Put simply, he makes things blow up. Things like me and my team of misfits, who, until Junkrat showed up, were seconds away from winning the match.

That's *Overwatch*, a multiplayer character-based shooter in which 12 players compete across two teams to fulfil whatever objective the map asks of them. I say character-based rather than class-based because that's an important distinction. Widowmaker and Hanzo are both snipers, but play completely differently. Mercy and Lucio are both healers, but one uses a staff that shoots healing energy, and the other uses, well, phat beats. Each character fits into a broader category, but is otherwise unique. Weapons, abilities, ultimates and even movement are specific to that hero.

It's a shooter then, but with a MOBA attitude to character design. But to be clear: *Overwatch* isn't a MOBA. Rather, it's as if *Heroes of the Storm* went to *Team Fortress 2*'s house party, and left without cleaning up after itself. There's no lane-pushing, AI creeps, item shopping or levelling. Objectives are straight out of the class-based shooter playbook: points to attack and defend, payloads to push and hills to king. But the characters have abilities reflective of their style and personality, and those abilities have cooldown timers, so less spamming.

There are characters who improve map visibility, soak up incoming damage with shields, or throw out armour for teammates to pick up. There are characters who lay traps, or debuff or stun enemies. There are also characters who use a jetpack, teleport long distances or boost movement speed for every teammate within an area of effect. It's a wide and varied roster with a plethora of styles and abilities.

As a result, some of the game's systems are more streamlined than you'd expect from a class-based shooter.

ALL THE MOVES

Part of the process of playing *Overwatch* is learning the characters, their abilities and how to counter them. This can be both gratifying and infuriating – hence why I currently hate Junkrat. Previously, I've hated the sentient turret Bastion, the assault rifle-wielding Soldier: 76, the sniper Widowmaker, the engineer Torbjörn and, briefly, the shuriken-throwing Genji. Tomorrow, I'll likely hate someone else. It's a work-in-progress list, which changes with each new revelation over how to identify, avoid and eventually nullify a particular style of play.

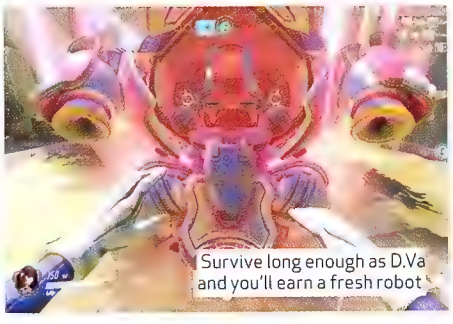
With so many heroes to choose from, and only six players per team, composition is vital. Again, experience comes into play, and after a few hours, you'll get a feel for some effective combinations. The interface does a good job of cajoling players into making sound picks. During the opening seconds of a match, the entire team sits at the character selection screen, picking heroes while a tooltip critiques the overabundance of snipers or lack of a support. It works more often than it doesn't – I've seen players guiltily snap up their favourite pick before grudgingly switching to a tanking character for the good of the team. Still, sometimes, you're going to end up on defence with two Hanzos and a Widowmaker. No tooltip can fully eradicate human stubbornness. At least such matches tend to be short.

The end of match 'Play of the Game' clip doesn't exactly help. As the name suggests, it caps things off with a brief clip showing the most impressive action of that round from the perspective of the player. Right now, the algorithm seems to favour multikills, thus a specific roster of heroes. You'll see Bastion mow down a string of helpless attackers. You'll see Torbjörn hammering away at his turret. You'll see Junkrat's tyre bomb blow up half a team. Sometimes, rarely, you'll see a support character do something helpful. I suspect that only happens when nobody achieves a big enough killstreak.

Mei is an ice troll in human form.

Arrows: more powerful than almost any bullet.

You can destroy things before the start of each match.


Survive long enough as D.Va and you'll earn a fresh robot

While individual characters each have a couple of hard counters, things become more complicated across an entire team. Bastion, when operating as a sole agent, is easy enough to deal with. But a Bastion protected by Reinhart's energy shield is a powerful combination, especially if both are supported by Torbjörn's upgraded turret.

In *Overwatch*, communication is just as important as experience. It feels like there are specific hero combinations that – in pub play, without the unity that comes from fighting with friends – can be very difficult to unpick.

A lot of that is down to the maps and the few, specific locations where things become slightly too restrictive. For the most part, the maps are great – an interesting flow of chokepoints, corridors, open areas and alternate routes. The best provide specific pathways for each type of hero – be it a wide main corridor for lumbering tanks, narrow flanking routes for squishy attackers, or balconies for those heroes who can climb, clamber, grapple and fly.

SPOKES

Despite being set in a future version of our own world, *Overwatch* still looks and feels like a Blizzard game. It's bright, vibrant and quirky – its characters are a mixture of lovable rogues, gruff villains and over-the-top heroes. It's a diverse cast, and yet one that feels cohesive within the hyper exaggerated, cartoonish setting. It's all tied to a story about futuristic terrorism, robot uprisings and a disbanded group of heroes. For the most part, this tale is told externally, through comics and short films. It feels incidental to the action.

In action, *Overwatch* looks exhilarating. Matches are a light show of effects, as weapons fire and abilities trigger. Expect the first few hours to be overwhelming, as you learn what each effect means and why it just killed you. Eventually, as you start to parse the information behind the effects, it feels surprisingly clean. The weapons, for the most part, feel good: big, powerful heroes shooting big, powerful guns. Roadhog's chunky scrap gun is excellent, as are Reaper's dual shotguns. Not all are so substantial. Beam weapons and assault rifles are both a little underwhelming. The same holds true of abilities and ultimates – some are just more enjoyable to use.

LIKE CLOCKWORK

Overwatch runs beautifully. Its options are highly customisable, and I've yet to experience any framerate drops playing on Ultra settings at 4K with a GTX 970. As for online performance, the only lag I've experienced was isolated to a few hours on a single evening – probably more the fault of my sluggish home internet connection than Blizzard's servers. And despite some predictable post-release downtime, servers have remained steady across launch week.

Matchmaking can, however, feel a bit wonky at times. Queue for a round, and the system places you with a group that the underlying maths has judged to be your equals. That doesn't always feel like it's the case, although it's a hard thing to judge in an online game.

It's tricky to nail down how good *Overwatch* is, because, in a multiplayer game, emotion can't operate as the guiding light of an inherently subjective process. Here's what I can say for certain, though: *Overwatch* is a great, often fantastic shooter, and filled with clever design decisions. But as good as it is, there are some rough patches to be found underneath Blizzard's peerless polish. ■ **Phil Savage**

Verdict

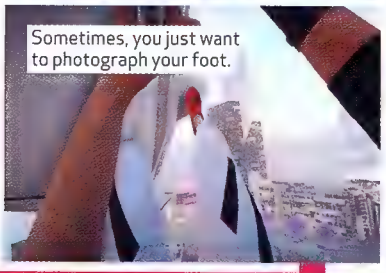
It's not flawless, but *Overwatch* is still one of the best new multiplayer shooters to arrive in years.

★★★★½

Dress like that and you're basically asking for a dystopian regime.

At full speed, the scenery starts to look like this.

This makes me think how good the next Mass Effect will look.


Sometimes, you just want to photograph your foot.

FROM $88 | PC, PS4, X1 | WWW.MIRRORSEDGE.COM

Mirror's Edge Catalyst

Parkour Life.

Mirror's Edge Catalyst is, like its predecessor, a first-person platformer based on free-running. The big switch-up this time is that it's set in an open-world playground, rather than a series of linear levels. But far from being an open world in the mould of *GTA*, this is a sort of *Zelda*-style hub, with new areas opening up over time as your toolset expands.

Introduced in *Catalyst* is the 'magrope', a sort of grappling hook that attaches to specific points in the world. Acquiring this and upgrading it provides new ways of getting around. But while it's as intricate, complex and exhilarating (when it comes to platforming) as its predecessor, a flawed new combat system sadly holds it back from being the perfect version I was hoping for.

For those who loved the free-running in the first game, that's more or less as you remember it. Running up walls, sliding under pipes and performing skill rolls from great heights still requires precise timing and sharp instincts – this is exactly what I loved about the first game, and it's all intact. The magrope is a neat addition – I just wish there were more places you can use it. There aren't many points it latches onto – no doubt an attempt to avoid stealing attention from the free-running. Going open world was the right move. The map is full of optional stuff to do – parcel deliveries, time trials, or even creating time trials and climbing challenges yourself using the simple in-game social tools – but I recommend leaving all this until you've finished the game.

The first *Mirror's Edge* was chewed out for its flawed combat, which relied on disarming enemies and very basic melee attacks, as well as firing guns. Well, guns are gone, which may be welcome news – but everything else is a little more mixed.

At its most basic, combat is improved. It works in two ways: if Faith is running at full speed, a quick tap of the light attack button knocks an enemy out of the way and she can keep running. It's functional and there to facilitate your free-running, and feels like the sort of thing that would've made a lot of sense in the first game. Faith is also protected by something called a focus shield, which means you're safe from gunfire any time you're running at full speed.

At first, this new system seems cool – running across rooftops, then booting a guy to his death before escaping can feel exhilarating, and makes Faith feel like a superhero as the law enforcement pursues her, *GTA*-style. But after a few fights, I started to get tired of how low energy the scraps felt, and the annoying enemy types that spam you with cheap attacks. The combat wouldn't be so bad if you could skip every fight. Most of the time, you can, but there are at least three mandatory encounters during the story (two take place in the exact same area). And they're by far the worst parts of *Catalyst*.

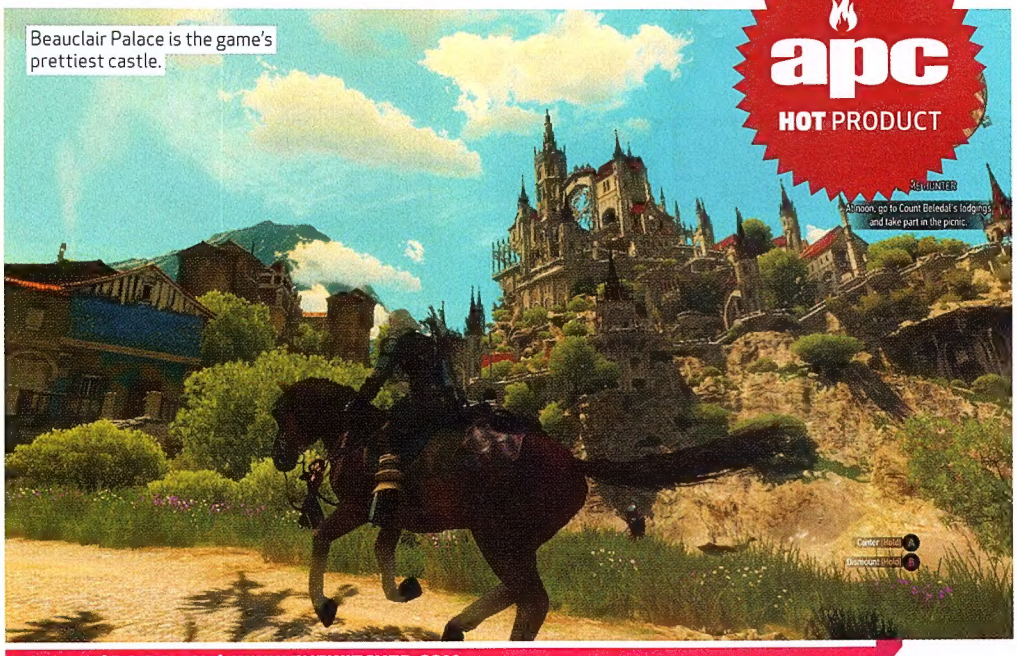
Despite the missteps with combat, and another storyline that is just too dry to get invested in even with well-produced cutscenes, I still recommend *Mirror's Edge Catalyst*. It's annoyingly close to being the ideal *Mirror's Edge* game, but retains a few of its predecessor's issues, even if those problems have manifested in slightly different forms.

■ Samuel Roberts

Verdict

As close to a definitive version as we're likely to get, despite retaining some of the issues of the original.

★★★½



Beauclair Palace is the game's prettiest castle.

US$19.95 | PC, PS4, X1 | WWW.THEWITCHER.COM

The Witcher 3: Blood and Wine

A fantastic farewell to a great fantasy RPG.

Have you ever wanted to get drunk with a vampire? *The Witcher 3*'s *Blood and Wine* expansion gives you that opportunity, and lets you ask all the important questions. What's it like to die and come back? What's it like to live for centuries in a world that mostly wants you dead?

You're invited to the huge, gorgeous new region of Toussaint by the Duchess, who wants you to slay a creature targeting elite knights in her retinue. A twisting detective story unfolds as Geralt investigates the murder scenes and begins to hack through a series of interlocking plots.

The plot has superb pace and variety throughout. Geralt awkwardly picks his way through an artist's soiree, storms a castle or two and has a creepy encounter with a spotted wight. Vivid characterisation and some great voice work – particularly from Geralt's main ally – sells the world.

The story takes roughly ten hours to finish if you slavishly blast through the missions in order, but there are many side quests to enjoy. Seek out grandmaster gear for multiple witcher schools, collect armour dyes, tackle monster hunts, join a tourney and compete in Gwent competitions to take on the expansion's new Skellige deck. With these, you'll easily reach the billed 30-hour play time. Early on, you get your own vineyard, which can be upgraded – slowly, at great cost – for access to useful adventurer amenities. Once you've taken a particular opening quest, you can start working towards the new mutations, which let you put ability points into powerful ability modifiers.

While not revolutionary, mutations are a productive place to put your points as you move to Level 40 and beyond, but I found more worth in the new armour sets and the magical bonuses they confer. In a green flash, I now absorb enemy life force with every killing blow thanks to a suave set of ancient black gear. This is the most fun I've had with *Witcher 3*'s combat. There are some decent boss fights and the extra abilities at high levels generate more interesting options.

Toussaint itself lends this adventure a different flavour. It's a sun-drenched land of relative opulence. The Duchess' castle, and the azure and terracotta town of Beauclair at its foot, create a postcard-perfect centrepiece. As you ride around the outskirts, you can almost always see the shining white spires of the palace. The winding trails reliably offer stunning vistas, cleverly arranged by CD Projekt's environment artists, yet, where required, the landscape can hide an ancient dungeon or a foggy graveyard, or the site of a bloody massacre.

Fantasy RPGs offer us the chance to walk through the pages of pulp fantasy fiction, to stand opposite the wights, witches and wizards of those stories. *The Witcher 3: Blood and Wine* is an accomplished piece of genre fiction, with some characters I'll come to miss. ■ **Tom Senior**

Verdict

Sumptuously detailed and full of distractions. An outstanding farewell for the series.

★★★★★

Dungeons 2

Not quite the Keeper.

US$39.99 | PC, PS4
DUNGEONS-GAME.COM

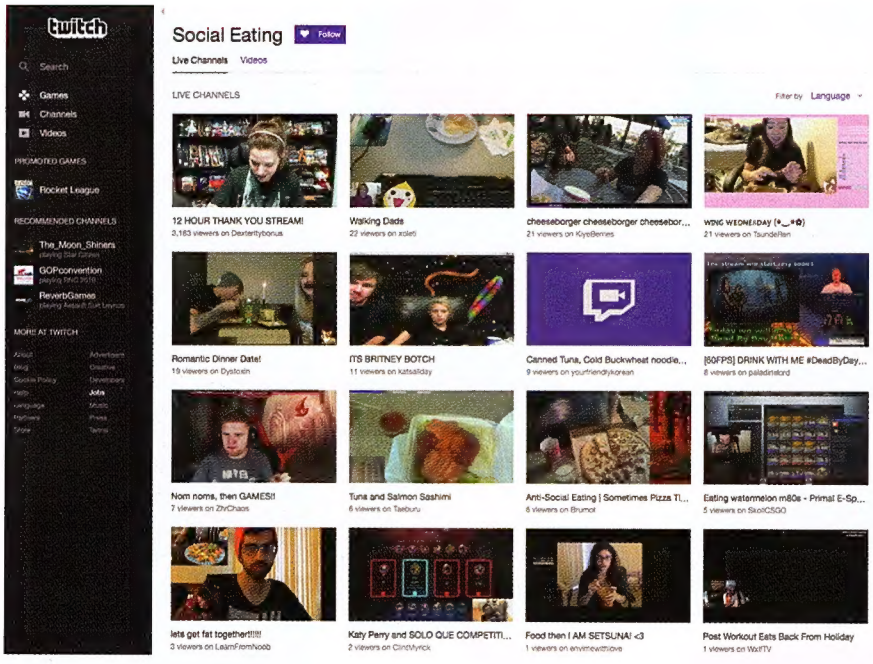
Remember *Dungeon Keeper*? Realmforge Studios does. At its heart, *Dungeons 2* is the off-brand Aldi version of Peter Molyneux's subterranean, gribbly management game: cribbing the essence and packaging it up in a suspiciously similar box that tastes almost as good.

Realmforge, however, isn't done with modifying the formula. Alongside the trap-building, room allocating and treasure hoarding of yore, you can also taste the fresh air of a surface overworld. This delivers a splash of colour, but more importantly brings purpose to each of the campaign's missions, as you seek to extract vengeance on the do-gooders who banished your mortal form in the tutorial.

If it gelled, it would make for a smart addition to the genre. Instead, the switch in controls from disembodied hand to clicky RTS-style management is cumbersome, and selecting units to activate their skills with any kind of precision in a scrum is out of the question. Spells, meanwhile, are often limited to your territory, so it's tough to get a lot more granular than vaguely gesturing where to go and hoping the classically dim-witted creature AI will figure it out.

Humour is a big part of these games, but the script is also hit and miss. The result is largely decent, if derivative, but glinting away in the torchlight are constant hints of what might have been.
■ **Matt Clapham**

» CARMEL SEALEY REPORTS ON THE LIGHTER SIDE OF TECH NEWS



Twitch launches 'Social Eating' hub

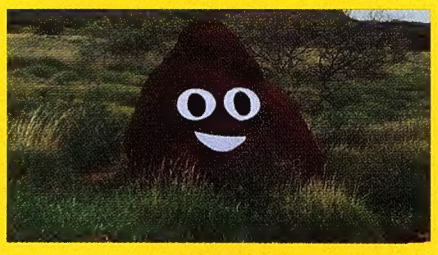
Watch people chow down 24/7.

If you know where to look, the world is full of eating competitions – 1kg schnitzel, chips and beer challenges; 1kg burrito challenges; hotdog challenges; chilli eating challenges... all with a surprisingly large number of spectators willing to watch contestants stuff their faces. Now, the live-streaming video site Twitch has opened itself up to this world by adding a hub called Social Eating. At time of writing, there were only a few regular contributors (including an army photographer turned cook, plus a gamer who livestreams his gaming session but accompanies it with a live view of what he's eating – mostly takeaway, by the looks of it), but considering the number of 'photo foodies' out there, we're confident this section will fire up. If someone eats a whole packet of dry Weet-Bix, I might tune in.

VR porn festival in Japan shut down...

BECAUSE IT WAS TOO POPULAR.

We're going to leave our puns at the door, we promise! The first VR porn festival in Japan had to be postponed in early July this year due to overcrowding at the venue. According to statements made by hopeful attendees on social media, the Akihabara district (where the event was to take place) was already teeming with excited and curious people well before the start time. Apparently, some feared a riot would commence once people knew they wouldn't be getting in to see the festival and policemen were called to disperse the crowd.



This poop-emoji ant mound is certainly creative...

BUT IS IT ART?

At my local bits-and-bobs shop are several pairs of poop-emoji slippers and a newly arrived poop-emoji onesie. There's definitely a market for emoji merchandise. However, Danny and Amanda Fitzgerald have taken the poop to outback Western Australia and turned a termite mound along the North West Coastal Highway into a giant poop. True, termite mounds look like poops already, but the pair have added the bright eyes and proud grin of the emoji we all know and love. Art is a very subjective thing, modern art especially, and we're wondering whether this will start a new trend of emoji-environment 'pieces'. Perhaps we'll see something at the next Sculptures by the Sea...

RSI from your keyboard and mouse is so last year

THE TRENDY NEW TECH INJURY IS 'SELFIE ELBOW'.

Personal opinions of selfies and selfie-takers aside, is it actually possible to take enough selfies to cause repetitive strain injury to your wrists and elbows? According to Mary Ann Wilmarth, a doctor of physical therapy, this 'selfie elbow' strain is related to 'tennis elbow' or 'golfer's elbow'. This new picture-taking condition occurs from the unnatural position of the extended, straight arm and hooked wrist. But Wilmarth also stresses that it's not just the arm that you could be damaging taking those selfies, but also your neck and shoulders, too. But before you go out to buy a selfie stick, Wilmarth makes note that, depending on how you hold yours, it may not actually make any difference. ■

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